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and Applied Chemistry (IUPAC)**

# **Information Bulletin**

**A news magazine about  
developments in Chemistry involving  
subjects of International importance**

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# Information Bulletin

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## Unnilquadium, $_{104}\text{Unq}$ : A new element breaks the name barrier

The naming of the new man-made element with atomic number 104 marks the beginning of a period in chemical history when new elements will be named systematically for the first time. It also resolves an intense controversy that has lasted more than ten years. That's the good news. The bad news is that the new naming system is probably 100 years too late to have much significance for the average chemist.

In recent decades, the formation of new man-made elements was made possible by the construction of large particle accelerators. For the most part, new elements are made in only tiny amounts. They are radioactive, and decay to more stable nuclides within a short time. Few such elements have found practical applications. One interesting exception is Californium-252, which is used as a neutron source for measuring trace amounts of metals with Neutron Activation Analysis. Elements with atomic weights above 100 appear to generally be very unstable. The highest atomic weight formerly achieved was Lawrencium (atomic number 103), produced by bombarding Californium-249 with boron nuclei.

There are now only 2 particle accelerators large enough to produce new elements; one in the US, the other in the USSR. Nuclear chemists from both countries claimed to have first discovered the new element with atomic number 104. Each group proposed a name for the element.

So how do you name an element that rapidly undergoes radioactive decay, can be made by only two particle accelerators in the world, and whose existence could not be proven with certainty? That problem was undertaken by the IUPAC

Commission on Nomenclature of Inorganic Chemistry. It required years to resolve. Since neither group could prove that they first made the new element, the Commission adopted neither proposed name. Instead, they introduced a systematic method for naming newly-discovered elements. The name of an element would follow directly from the digits in the atomic number (for Unnilquadium; Un = 1, nil = 0, quad = 4), and end with "ium". The system can be extended up to the hypothetical element with atomic number 999 (Ennennennium,  $_{999}\text{Eee}$ ).

It is conceivable that a few new elements will be discovered with exceptional stability, but most likely, elements with atomic numbers above 104 will exist for fleeting moments and will be only a curiosity for a few nuclear physicists.

As pointed out by the chairman of the Inorganic Nomenclature Commission, Prof. J. Chatt, new organic compounds and inorganic complexes are named by a systematic method, so why shouldn't new elements? He also notes that elements have *not* always been named after their original discoverers. Prof. Chatt had advocated years ago that element number 100 be called "Centurium", with subsequent elements named systematically. This was not to be. Before the new naming system was finalized, Mendelevium ( $_{101}\text{Md}$ ), Nobelium ( $_{102}\text{No}$ ) and Lawrencium ( $_{103}\text{Lr}$ ) were discovered.

For those ambitious chemists and nuclear physicists who do hope to produce new elements, details of the naming system can be obtained in the February issue (No. 2) of *Pure & Applied Chemistry*.

## Synthesis of new fluoride compounds aims at synthetic blood

Remarkable progress has been made towards a totally synthetic blood substitute. It now appears conceivable that such a blood substitute could be used as a universal blood replacement in surgical transfusions. It would be compatible with all types of human blood, could be preserved for long periods of time, and would not pose the risk of transmitting such diseases as hepatitis. For victims of accidents, it could be administered immediately in a blood transfusion, eliminating

the need for time-consuming typing and cross-matching. It would allow the use of powerful cancer-treating drugs, which must normally be used in very restricted doses to prevent destruction of red blood cells. Finally, it could provide a versatile tool for medical research, since the composition of synthetic blood could be closely controlled so that one particular hormone, enzyme or other constituent could be accurately monitored.

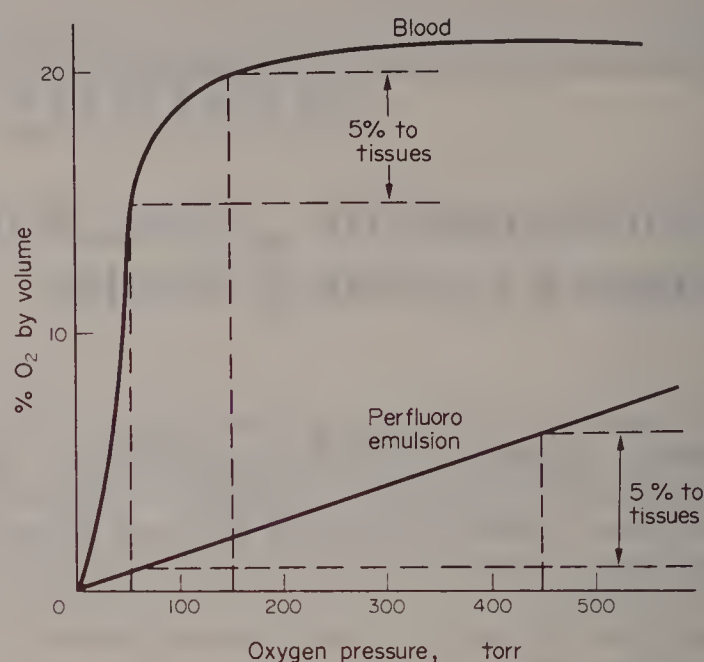


These applications are proposed in a remarkable paper reviewing experiments in the synthesis, testing and physiology of blood substitutes. The paper, *Perfluoro Compounds as Blood Substitutes*, discusses recent experiments in which animals survived massive replacement of their blood with emulsions of fluorinated compounds, and continued to live, grow and develop normally. In one experiment, a rhesus monkey appeared to be unaware that one-third of his blood volume had been replaced. He apparently suffered no physiological, chemical or psychosocial harm and was still alive a year later. Another experiment replaced nearly *all* the blood of rats. Upon awakening from anaesthesia after the transfusion, the "bloodless" rats immediately resumed eating, drinking, building nests and behaving the way rats normally do. Concentrations of red blood cells and plasma proteins returned to normal levels within about 10 days.

There are still problems to be overcome. So far, experiments have been limited to those few perfluorinated compounds which are produced commercially for entirely different purposes. None of these have been found to meet all criteria for a satisfactory blood substitute. Only emulsions of F-tri-n-butylamine have been successfully used for total blood substitution in experimental animals, and this compound is retained for long periods in the liver. Other compounds, such as perfluorinated decalin, are eliminated from the liver within a few weeks with no apparent irreversible damage to the liver or other organs. However, emulsions of F-decalin are not very stable.

Indeed, characteristics and toxicity of the artificial blood systems are not determined solely by the choice of perfluoro compound, but depends very much upon the particle size and distribution of the perfluoro compound in emulsion. Mineral salts and other water-soluble components of blood plasma do not dissolve in perfluorinated compounds. So researchers prepare emulsions of the oxygen-carrying perfluoro compounds in a carefully-chosen salt solution. The size of the emulsified particles is crucial—acute toxicity increases rapidly with the proportion of particles larger than 0.4  $\mu\text{m}$  diameter. Most of the emulsions now prepared have an average particle size of less than 0.1  $\mu\text{m}$ , which makes them look nearly transparent.

The limited content of perfluoro compound in an emulsion, perhaps 25% by volume, restricts the oxygen-carrying ability of blood substitutes. So far, all experimental animals which have undergone blood substitution have needed to breathe oxygen-enriched gas. The reason follows from the basically different characteristics of oxygen transport by red blood cells and by perfluoro compounds. Hemoglobin *chemically binds* oxygen, and is nearly saturated when exposed to gas with a partial oxygen pressure of 150 torr (the normal oxygen pressure in the lung). When saturated, blood carries about 20% its volume in oxygen. About one-quarter of this



After leaving the lungs, oxygenated blood releases oxygen equivalent to 5% its fluid volume as it passes through body tissues. The same release of oxygen has only been achieved with synthetic blood substitutes by maintaining a high partial pressure of oxygen (about 450 torr) in the lungs.

oxygen is released to body tissues before return to the lungs. Emulsified perfluoro compounds, on the other hand, *dissolve* oxygen and require a much higher oxygen pressure to carry the same amount of oxygen. To release the same oxygen volume to body tissues as does blood (5% of fluid volume), the perfluoro emulsion must be exposed to a 400 torr difference of oxygen pressure between leaving and returning to the lungs.

Can new perfluoro compounds be synthesized that have greater oxygen-carrying capacity, are readily emulsified, and are excreted completely without damage to body organs? For the first time, investigators are now attempting to synthesize such compounds specifically for use in blood substitutes. Homologous series of compounds will need to be prepared and tested on a systematic basis. Synthesis methods formerly used for perfluorination produced a range of similar compounds, each of which is difficult to obtain pure and in good yield. But investigators are developing new synthesis techniques to improve the specificity of fluorination reactions. Some are improving electrochemical or direct fluorination of the parent hydrocarbon, some begin with simpler fluorinated starting materials, and other groups are developing specific chemical routes. All of these methods are discussed in the paper, *Perfluoro Compounds as Blood Substitutes*, published in the September issue of the International Edition of *Angewandte Chemie*.

One author of the *Angewandte Chemie* paper, Prof. Dr. J. C. Riess (of the Laboratoire de Chimie Minérale Moléculaire, in France) adds that further studies have been made on the fate of perfluoro compounds in experimental animals. These confirm the absence of carcinogenicity and teratogenicity of perfluoro emulsions. There has



been particularly intense activity by Japanese research groups. An international symposium was held recently in Kyoto, Japan to consider progress in Perfluoro Blood Substitution. One improvement that has been reported is a stable emulsion containing *two* perfluoro compounds, which has successfully maintained dogs and monkeys alive for 6 h following near-total transfusion of their blood (afterwards, their own

blood was returned).

One problem that now appears to be greatly reduced is the difficulty of comparing fluorocarbon emulsions tested in different laboratories. Each research group has tended to use their own procedures for transfusions. However, researchers are now adopting standard procedures for transfusions in experiments with rats.

## Less food spoilage could result from wide use of new copper test

The presence of copper in food at trace concentrations significantly accelerates the rate at which fat becomes rancid by air-oxidation. Spoilage is promoted at concentrations as low as several parts-per-million. Even foods not normally thought to contain fat (chocolate and milk powder, for example) are subject to accelerated spoilage by handling in metal equipment containing copper.

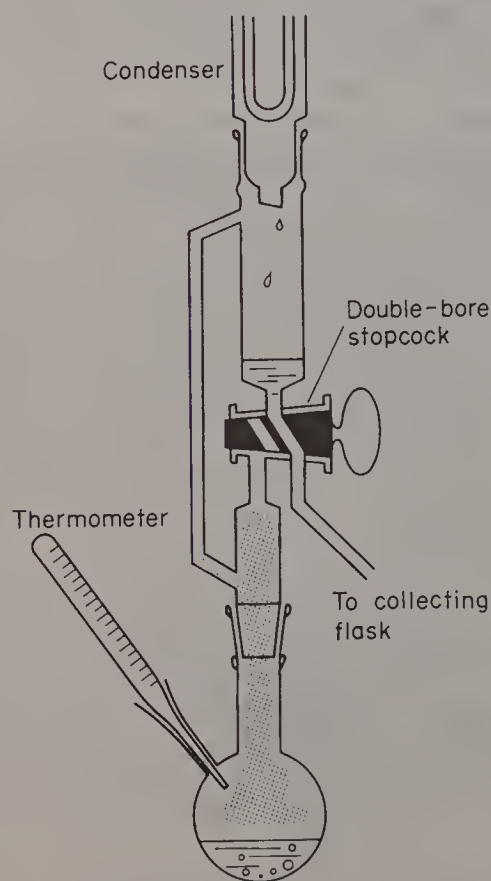
The need for an accurate test able to monitor the concentration of copper in all foodstuffs and biological material has long been apparent. A general method for copper analysis was devised by IUPAC in 1959. Since then, widespread availability of Atomic Absorption Spectrophotometers made it feasible to devise a testing procedure which offered greater accuracy and speed. Now, an improved spectroscopic technique has been advanced by the IUPAC Commission on Food Contaminants. The new test is capable of analyzing for copper in all foodstuffs and biological material at concentrations down to 0.05 ppm.

The sample of food or biological material under test must first be wet oxidized by treatment with hot concentrated nitric and sulfuric acids. The mixture is transferred to a glass digestion apparatus, and allowed to stand overnight to prevent foaming during the initial digestion. The flask is heated gently at first, with condensing liquid allowed to reflux back into the flask. Strong heating is then applied, and the stopcock turned, so that liquid distills into the receiver section of the apparatus. Several times during the digestion, collected distillate (consisting mostly of water at first, then nitric acid) is drained into another flask by rotating the stopcock.

After digestion, the resulting solution has a volume of one millilitre or less. It is diluted with water, and the pH adjusted. Copper in the solution is complexed with the chelating agent ammonium pyrrolidine dithiocarbamate. The resulting copper complex is separated from the water solution and concentrated by extraction with the organic solvent methylisobutylketone.

Dissolved in this solvent, the complex is sprayed into the flame of an Atomic Absorption Spectrophotometer equipped with a hollow cathode lamp for copper, emitting at 324.7 nm. Absorbance of the sample solution is compared against that obtained with copper solutions of known concentrations treated in the same way.

Details of the procedure are described by the technical report *Determination of Copper in Foodstuffs*, published in *Pure & Applied Chemistry*, Volume 51, No. 2 (1979).



Before a sample is analyzed for copper, organic material must be decomposed in an apparatus like the one shown here. The sample is heated in acid, refluxed, then the acid distilled into the receiver below the condenser.

# Better method devised for coping with tracer compounds

Isotopically substituted compounds are recognized as one of the most valuable tools for investigating reaction mechanisms, both within the laboratory flask and in living organisms. An artificially-introduced isotope (originally contained by one reactant) can be followed at each stage in a chemical reaction or a metabolic pathway. Radioactive isotopes are detected by radiation counters; non-radioactive isotopes are monitored by mass spectrometry.

With increasing use of tracer compounds, a need had clearly developed for a method to indicate the position and extent of isotopic substitution in tracer compounds. The system formerly used for naming and writing formulas of tracer compounds was devised in 1934. With the passage of time, it became unable to deal with the increasing variety and complexity of isotopically-substituted compounds that have become commercially available for organic and biochemistry research. To fill this need, a new system was devised by the Commission on Organic Nomenclature, and has now been approved for general use.

Chemical compounds normally contain elements with the natural isotopic composition. Among hydrogen atoms, for example, 99.99% are normally ordinary light hydrogen ( $^1\text{H}$ ), and 0.015% are deuterium ( $^2\text{H}$ ). Compounds containing hydrogen and deuterium—and all other isotopes—in their normal ratio are said to be “isotopically *unmodified*”. Although pure compounds in the usual sense, they contain small amounts of many deuterium-containing isomers.

Through a deliberate (and often, very expensive) effort, it is possible to introduce into a selected compound a new isotope (tritium,  $^3\text{H}$ , for example) or an isotope normally present at only trace concentrations, like deuterium. As is generally true of all isotopes, hydrogen and deuterium have nearly identical chemical properties (although in a few cases, reaction rates may differ significantly).

For simplicity, let's consider only deuterium labeling. Deuterium-bearing compounds differ very slightly in boiling point. This allows the deuterium content of ordinary water to be upgraded by a difficult and costly distillation process. Deuterium can then be chemically introduced into a desired tracer compound. It is substituted for hydrogen at selected sites in the molecule. Such a compound has a deuterium/hydrogen isotopic ratio that is higher than normally found in nature, and is said to be “isotopically modified”.

Replacement of hydrogen by deuterium at particular sites in the molecule can sometimes be nearly complete. The compound is said to be “isotopically substituted”. The new rules provide for the atomic weight of the introduced isotope to be shown in the molecular formula. In the name of the compound, the introduced nuclide (deuterium, in this case) and its location are indicated in parentheses.

Often, it is not possible or necessary to completely displace the naturally-occurring isotope from selected sites in the molecule, or to ensure that substitution is restricted to these sites.

## Extent and location of isotopic substitution are indicated by new naming method

|                                                                                                                                       | FORMULA                                                       | NAME                                             |
|---------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------|--------------------------------------------------|
| <i>Isotopically Unmodified</i>                                                                                                        |                                                               |                                                  |
|                                                                                                                                       | $\text{CH}_3 - \text{CH}_2 - \text{OH}$                       | Ethanol                                          |
| <i>Isotopically Substituted</i><br>(Nearly every molecule has three $^2\text{H}$ on carbon-2 and one in the alcohol functional group) | $\text{C}^2\text{H}_3 - \text{CH}_2 - \text{O}^2\text{H}$     | (2,2,2- $^2\text{H}_3$ ) Ethan( $^2\text{H}$ )ol |
| <i>Specifically labeled</i><br>(only a fraction of molecules are substituted)                                                         | $\text{C}[^2\text{H}_3] - \text{CH}_2 - \text{O}[^2\text{H}]$ | [2,2,2- $^2\text{H}_3$ ] Ethan[ $^2\text{H}$ ]ol |
| <i>Non-selectively labeled</i><br>(Varied position and extent of isotopic substitution)                                               | $[\text{H}] \text{CH}_3 - \text{CH}_2 - \text{OH}$            | [ $^2\text{H}$ ] Ethanol                         |



Consider the case in which partial isotopic substitution has occurred such that *some* molecules contain deuterium at *specific* sites. The compound is termed "specifically labeled", and substitution is indicated in the chemical formula by square brackets. The position and number of substituted sites are also indicated in brackets in the compound's name.

Note that the formula of a specifically labeled compound may not represent the majority of molecules. In fact, the isotopically *unmodified* compound usually comprises the overwhelming bulk of the material.

Another possibility is for the tracer compound to contain several types of substituted molecules, each specifically labeled at one or more positions. Once again, the mixture will probably still consist predominantly of the unmodified compound.

The mixture of isomers is said to be "selectively labeled", and cannot be described by a unique structural formula. Nonetheless, those positions where substitution of the labeling nuclide is present in *some* molecules of the mixture is indicated in the formula and name of the compound.

Very complex labeled compounds can readily be accommodated by the new rules. Names and formulas can be described as well for *mixed labeled* compounds (such as those labeled with both  $^2\text{H}$  and  $^{13}\text{C}$ ) and *isotopically deficient* compounds. The new system includes detailed procedures applicable to the wide range of labeled compounds which could be encountered by the organic or biochemist. Complete rules have been published in the second volume (1979) of *Pure & Applied Chemistry*.

## Interest on plastic fillers follows wider use of composite materials

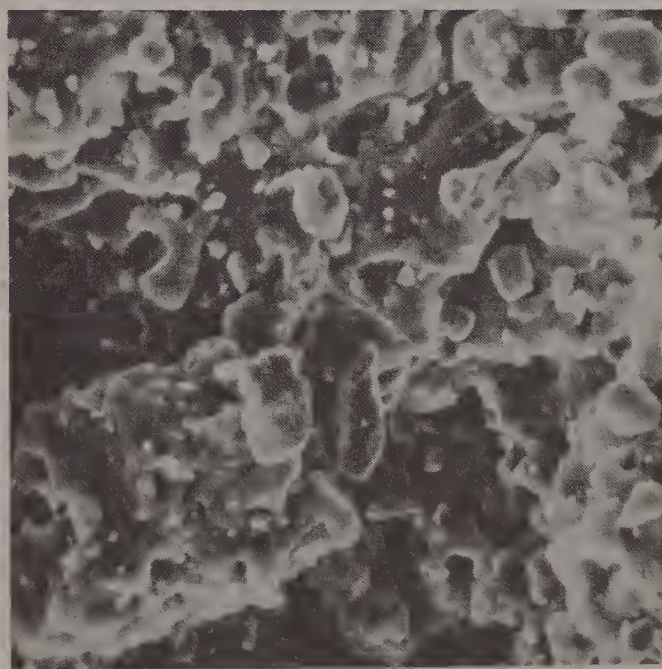
Manufacturers of plastic composites are focussing their attention on various methods of modifying physical properties of plastic materials. Plastic materials are being adopted for a wider range of applications as their usage steadily increases. Further growth in plastic usage will undoubtedly occur because of the much smaller amount of petroleum required to make plastics than the equivalent fuel required to mine metal ore, refine it and shape metal parts. Lower-weight plastic parts will also reduce the weight of vehicles, decreasing gasoline (petrol) consumption.

Physical properties and cost of plastic composites is altered over a wide range by changing the composition of the polymer, reinforcing with glass fibre, or by adding fillers. All these factors exert an important influence on impact strength, rigidity, density and cost. The effect of each will need to be examined more thoroughly and more systematically than in the past. To do this, several working parties have been established within the Commission on Polymer Characterization and Properties. These groups of industrial and university workers have been collaborating to investigate such subjects as the modification of polystyrene with rubber, flow characteristics of copolymers, and impact strength of mouldings. One such study has just been published by the group investigating "Structure and Properties of Commercial Polymers". They released the technical report *Mechanical Properties of Rigid Polyvinyl Chloride, Effect of Filler*.

The report examined the effect of calcium carbonate filler on the properties of polyvinyl chloride plastic. Greater rigidity of the material results from the addition of filler, the report notes, especially for coarse grades of calcium carbonate ( $2.4\ \mu\text{m}$  diameter) and at high filler concentrations. However, less impact energy was needed to start a crack when the plastic contained filler. This is especially important when filler

particles are unevenly distributed. Structure of the calcium carbonate particles seemed to have little bearing on initiation of cracks. Once cracking has already started, the filler increased the energy required to propagate the crack. The working party found this effect to be most pronounced at higher filler concentrations and with finer ( $0.07\ \mu\text{m}$  diameter) grades of calcium carbonate.

Organizations participating in the study were ICI, Montedison, Solvay & Cie, TNO (Delft), and the Technical University of Prague. Details of the report have been published in *Pure & Applied Chemistry*, March 1979 issue.



Calcium carbonate filler should be evenly distributed in PVC plastic to minimize the extent of cracking under impact. Here, plastic with 20% coarse filler has been fractured, and the surface observed with a scanning electron microscope at  $2000\times$  magnification.



## Caution: Nuclear war can be hazardous to health

It is now widely recognized that the ozone layer in the upper atmosphere is highly vulnerable to destruction by fluorocarbons (propellants in aerosol cans), and to some extent, nitrogen dioxide in exhaust from high altitude aircraft. Ozone strongly absorbs ultraviolet radiation below 320nm in wavelength, and normally screens more than 99% of this ultraviolet from sunlight. Even a 5% reduction in the amount of ozone in the upper atmosphere would increase ultraviolet radiation levels reaching the earth by 10%, and have serious effects. The consequences are still being debated, but clearly, there would be an increase in skin cancer (perhaps, one million cases globally, with 50,000 fatalities per year). Climatic changes are possible as well. Steps are being taken to replace fluorocarbon propellants with other materials. But there appears to be little attention given to another potential source of ozone destruction—nuclear war, even a so-called “limited nuclear war”. This appears to be one more reason (in addition to localized death, destruction and widespread radioactivity) to regard a “limited nuclear war” as a potential global catastrophe.

That is one conclusion of a report by Allen Hammond and Thomas Maugh II, presented in a case study in *Risk Assessment of Environmental Hazard*, published by the International Council of Scientific Unions through the Scientific Committee on Problems of the Environment (SCOPE). The case study examines how multiple nuclear explosions can introduce nitrogen dioxide into the upper atmosphere, partially destroying the ozone layer.

The study points out that the extent of ozone destruction that would follow a nuclear war is difficult to predict accurately. The amount of

ozone in the upper atmosphere naturally varies from day-to-day and during the 11-yr sunspot cycle. This natural fluctuation obscures low-level ozone depletion by man. Atmospheric ozone concentrations peaked in 1941 and 1952, but failed to peak as expected in 1963, after a period of extensive bomb tests in 1961–1962. On the basis of indirect experimental evidence, it was estimated that a 3–6% reduction of ozone in the Northern Hemisphere followed the nuclear testing period.

A thermonuclear explosion heats the surrounding air to very high temperatures, dissociating oxygen and nitrogen, and producing large amounts of nitrogen dioxide. As the fireball fades, rapid cooling stabilizes the nitrogen dioxide. Most is then deposited in the lower and middle stratosphere where ozone concentration is highest. According to authors of the study, “there is little doubt that the nitrogen dioxide will catalyse the destruction of substantial amounts of ozone before it is itself destroyed or removed from the stratosphere”. They cite the results of a study conducted by the US Atomic Energy Commission, stating that some ozone may be destroyed in the immediate vicinity of the explosion, but the more important ozone reduction is delayed. The maximum effect comes some months after the explosion. By that time, the spread of nitrogen oxides through the atmosphere ensures that the impact will be hemispherical, and ultimately global.

The report, *Risk Assessment of Environmental Hazard*, is the eighth in a series published by the SCOPE committee. The four-page case study “Stratospheric Pollution: Multiple threats to Earth’s Ozone” is found on page 22 of the report, which is available from John Wiley & Sons Ltd.

## Variation of atomic weights are accounted for by proposed changes

In assessing the most recent and accurate atomic weights for publication, the IUPAC Commission on Atomic Weights confronted a fundamental problem that had long been a source of difficulty. For many elements, atomic weights are not invariant, but depend upon the origin and treatment of the material. This is certainly true of elements with radioactive isotopes. The rapid decay of one isotope shifts the average mass of remaining atoms—effectively changing the atomic weight of the element. Even elements with stable isotopes sometimes show a variability depending upon the source of the element.

Elements whose isotopic composition has been intentionally altered are gaining widening commercial use as chemical tracers. The molecular

weight of compounds labelled with such elements is different than that obtained by adding the normal atomic weights of its elements.

Proposals were drafted after the 1975 IUPAC general assembly to define atomic weights in a new way. This change of definition has been agreed in principle and is discussed in the 1977 Table of *Atomic Weights of the Elements* (published in *Pure & Applied Chemistry*, Volume 51, No. 2, 1979). The proposed new definition will avoid entirely reference to the term “natural nuclidic composition”. No longer would *the* atomic weight of an element be referred to, but *an* atomic weight. This eliminates difficulties arising from elements whose isotopic composition varies in nature or has been “artificially” altered.



A typical problem which prompted the new outlook arose when the Commission tabulated atomic weights of hydrogen. The deuterium content of hydrogen in ocean water, lakes and rivers is 0.015%. When the respective concentrations of hydrogen and deuterium are used together with the latest values of relative atomic masses of these nuclides, an atomic weight of 1.00798 is obtained. However, the deuterium content of electrolytic hydrogen and polar ice can be as low as 0.0044%, leading to an atomic weight of 1.00787.

Inconsistent values will be avoided by the new method of defining and reporting atomic weights. Future tables of *Atomic Weights of the Elements* will provide relative atomic masses of each isotope. For the interim period, the 1977 report continues to

tabulate atomic weights according to the "natural abundance" of isotopes of each element. Atomic weights of certain radioactive elements such as radium and thorium are listed as the relative atomic mass of *the most stable* isotope. For others (such as promethium, polonium and radon), only the atomic mass number can be quoted.

Previously, no value of an atomic weight, or even an atomic mass number, had been tabulated for elements heavier than lawrencium (element 103), since names and symbols had not been agreed upon for these elements. That has now changed (see News Highlight in this issue). The new table of *Atomic Weights of the Elements* lists the atomic mass numbers of the longest-lived isotopes of elements 104, 105 and 106 (Unnilquadium, Unnilpentium, and Unnilhexium).

## A general theory of liquids is likely, but eludes researchers

Explaining the behavior of gases and solids was an early triumph of physical chemistry. But in *liquids*, movement of molecules is neither random (as in gases) or almost totally aligned (as in a crystalline solid). This intermediate state of partial disorder represents a complex situation—one not conducive to simple mathematical treatment. So, no general theory of liquids has yet evolved. Instead, various approaches have been advanced, each with its own set of approximations and assumptions. These various theories now appear to be approaching each other more and more closely. This remarkable trend was evident at the 4th International Conference on Solute-Solute-Solvent Interactions, sponsored by IUPAC and held at the Technical University of Vienna in September 1978. Among the speakers at the Conference, it was generally accepted that some structure is present in the orientation of solvent molecules around a solute ion or molecule. Clearly, this structure plays an important role in determining the properties of a solution.

Some Conference speakers approached the problem using theoretical calculations. Computers with greater computational ability have allowed "ab initio" calculations to be performed on small inter-molecular complexes. Statistical mechanical methods were also reported to be successful in dealing with complicated interactions of polar molecules.

Other chemists probed solution chemistry by applying x-ray and neutron scattering techniques. These methods were applied to concentrated salt solutions, and confirmed that water molecules around a hydrated chloride ion have a non-symmetric orientation. This conclusion agrees

well with the calculated orientation of water molecules around a chloride ion in the gaseous state.

Results of these recent experiments and theories provide encouragement and hope that a general theory of polar liquids and solutions might lie "just beneath the surface".

## Heavy reading

Do you have difficulty keeping up with scientific developments? That's not surprising. There are more than *twenty-eight thousand* scientific and technical periodicals presently being published. That's the number compiled by the Abstracting Board of the International Council of Scientific Unions (ICSU), the group which undertook the formidable task of finding, categorizing and listing scientific journals from all over the world. The information is now available in the *International Serials Catalogue*. It is an alphabetical listing of titles by "key words, an abbreviated version of the title, and unique ISSN (International Standard Serial Number) and CODEN code numbers used by libraries.

In case you want to know what you're missing, the catalogue can be purchased from the ICSU.AB secretariat, 51 Boulevard de Montmorency, 75016 Paris, or from, BIOSIS, 23100 Arch Street, Philadelphia, PA 19103, USA. The price is 40 US dollars.

# Chemical education group advocates less theory, more experimental courses

A major trend towards practical and experimental chemistry courses appears to be in progress, according to seven university teachers who attended the *International Conference on Introductory Chemistry*. They described the concern, often voiced by educators in the US, UK, Canada and Australia, that introductory courses are too heavily laden with complex and abstract theory, which many students do not understand. "Too much is being taught, too quickly, too superficially, and with too little long-term retention", the teachers state in their letter to the *International Newsletter on Chemical Education* (Dec. 1978). This view was apparently typical of the general feeling among the 115 high school, college and university teachers who attended the conference at McMaster University in Hamilton, Ontario.

The letter advocated that abstract topics should be de-emphasized or eliminated. Emphasis would be placed instead on teaching reaction chemistry and improving the comprehension of chemical principles. Further, they criticize high school chemistry courses that simply contain the same content as university courses, on a less sophisticated level. Authors of the letter point to "encouraging signs that major initiatives leading to curriculum reform have already been

taken — particularly in some Canadian provinces and in Australia".

Indeed, signs of curriculum reform in other countries were apparent from articles in the same issue of the *International Newsletter on Chemical Education*. A report about chemical education in Japan revealed a major trend towards experimental work. The Japanese Ministry of Education revised their "Course of Study" (guidelines for textbooks) in 1977, because the previous one was considered too difficult. Teachers are encouraged to include experimental work where possible, and place less emphasis on abstract concepts. Molecular Orbital Theory, for example, has been eliminated from the senior high school curriculum.

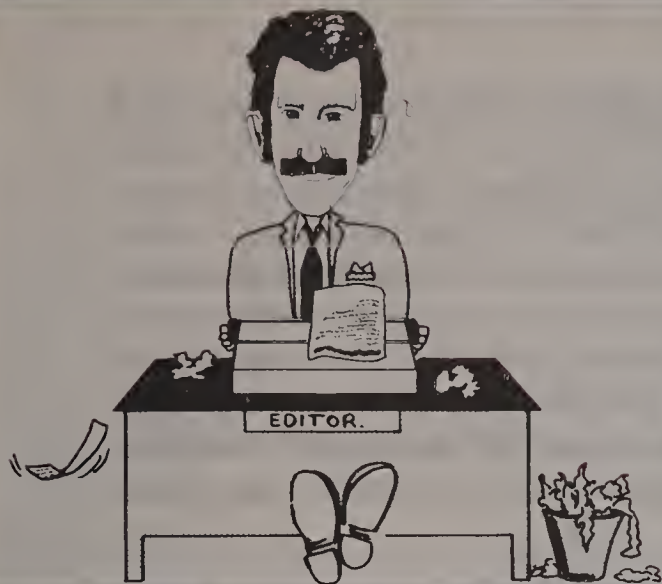
A report on education in Britain noted a parallel trend towards more school-industry cooperation. The School/Industry "Link Scheme" encourages direct contact between chemistry teachers and industrial chemists. It is supported by the UK Chemical Industries Association. Another group has been formed by the UK Chemical Society to bring together equal numbers of academic and industrial chemists into a working committee. The committee, termed SACRHEI, plans to set up a "Centre for Higher Education and the Chemical Industry".

## Subject listing of nomenclature rules available

A primary function of IUPAC is to develop rules for naming chemical compounds, symbolizing formulas, and presenting data. Nomenclature rules are initially published in provisional form. Comments are sought during the following period, and changes may be incorporated before the recommendations are approved for publication in definitive form.

Nomenclature reports — provisional and definitive — have been categorized *by subject*, and compiled into an alphabetical index with 60 subject headings. Provisional and definitive reports are clearly distinguished by different typefaces. The three-page index is available free-of-charge from the IUPAC secretariat, 2-3 Pound Way, Cowley Centre, Oxford OX4 3YF.





## THE EDITOR'S DESK

### First steps into the unknown

*Hundreds of millions of years ago, the first prehistoric animals lumbered out of the sea, and evolved into land creatures. At first, they were no longer adept at survival in the water, and not yet fully adapted to breathing air. In the same way, the Information Bulletin is venturing out into new territories—and a much wider role in the world chemical community. This issue represents the first big step.*

*During its transition, the Information Bulletin will contain less extensive coverage of committee meetings, and more general articles and information for chemists inside and outside IUPAC. When the changes are complete, the Information Bulletin will be very different from what it was before. In 1980, it will be published more frequently and its name will probably be changed to reflect its wider outlook.*

*What type of articles can you expect to see? To answer that, let me mention those changes that I think will exert a major influence on chemistry before the end of the 20th century . . . changes that will affect the outlook, the work, and the lives of chemists in most countries.*

*Do you remember fuel cells? When these remarkable devices were developed in the 1950's, chemists thought that fuel cells would have tremendous impact upon power generation and transportation industries. They projected that automobiles would be powered by silent, pollution-free catalytic oxidation of fuel, liberating combustion energy directly as electricity. However, it soon became apparent that fuel cells were then too expensive and impractical except for powering space satellites. The initial euphoria subsided, and fuel cells became almost forgotten. That was 25 years ago. Now, new types of high-temperature fuel cells are being developed that utilize robust, inexpensive catalysts to convert a range of hydrocarbon fuels directly into electricity. After a dormancy of 25 years, a new generation of fuel cells could emerge to meet the high expectations and broad range of applications originally foreseen for fuel cells years before. In future issues of the Information Bulletin, I will examine these new fuel cells, what they can do, how they work, and the role that high-temperature catalytic oxidation will play.*

*Another topic I intend to explore is controlled nuclear fusion. A few years ago, it was thought unlikely that plasmas at 100 million °K could be contained long enough for deuterium nuclei to fuse together, releasing enormous amounts of energy. It now appears probable that commercial fusion reactors will be operating early in the 21st century. In the long-term, nuclear fusion could generate most of the energy requirements of the human race for thousands of years. The control of nuclear fusion will almost certainly be a technological achievement unparalleled in history, and the greatest triumph of nuclear physics. But how about the chemist? What role will he play in the attainment and utilization of fusion energy. This too is a question that should be explored in upcoming issues.*

*There will be coverage of other interesting and exciting topics. What these topics are will be largely up to you, and other readers of the Information Bulletin. You might be very knowledgeable about a suitable topic, and perhaps not even realize it. During the years of working in your field of expertise, you have needed to concentrate on those developments directly involved in your present project. But surely, your work is one component of a major—perhaps international—effort that could lead to new products, improved techniques, and a new direction for further research. You probably have not given much thought recently to the significance of your work, or how its basic principles could be applied in other areas. There are probably many chemists who could benefit by knowing something about developments in your field, but may not even be aware that it exists. Why don't we tell them?*

*Martin Sellen*

## LETTERS

### Too much safety is imposed by law

One topic which I feel IUPAC, by virtue of its eminence and impartiality, could concern itself with the question of safety in chemical matters. Clearly no one would wish to advocate hazardous practices or procedures but I feel the "safety industry" in the world at large has so extended its influence and demands as to become counterproductive of benefit.

With OHSA in the U.S. and recent Health & Safety Legislation in the U.K. a climate of opinion is being created which, if allowed to grow unimpeded, will eventually lead to the cessation of much valuable innovational work. Moreover, with the decline in the involvement of school children in practical chemistry (on safety grounds) the generation of interest in the subject at the grassroots is obtunded.

My view is that safety is a comparative subject and should be treated as such and that a heedless quest for absolute safety must prove eventually destructive. This last is especially relevant when one considers the manner in which the man in the street knowingly

poisons his lungs with tobacco carcinogens and his liver with alcohol while being motivated by the media to complain bitterly of (comparatively) trivial hazards such as accidents of the Seveso type.

Someone, some agency, must redress the balance and put things into perspective. Who or what better than the new IUPAC Information Bulletin and its new Editor?

Dr. J. F. Cavalla  
Commission on Medicinal Chemistry

*I feel that the present public outcry against chemical spills, accidents and pollution is an over-swing that inevitably resulted from sloppiness or neglect formerly practiced by a few companies. There was an excessively long delay before measures were introduced to promote safety in the chemical industry and in the laboratory. To compensate for their initial inactivity, governments over-reacted.*

*It is unfortunate that all blame has been dumped on the chemical industry. Some should fall on the consumer. It is he/she that insists on plump insect-free apples, high-performance automobiles, and artificially-coloured frozen peas—at the cheapest possible selling price. That price is now being subsidized by our health, comfort, and forced compliance with regulations.*

*The Editor*



# New factors influence outlook for organic material supply

Adequate supplies of hydrocarbon fuels and materials will be available only if industrialized nations undertake a massive research and development effort. That became apparent at the outset of the unprecedented *CHEMRAWN* conference. But **which** resources could supply our hydrocarbon needs into the 21st century? And **how** should these be developed? It was these questions that the conference confronted, and a surprisingly consistent outlook emerged.

Since the conference was held nearly a year ago, major political and technological events have occurred. The *CHEMRAWN* theme (CHEMical Research Applied to World Needs) has become even more relevant in light of these developments. Basic conclusions reached at the conference remain intact, but some have acquired new significance, and all should now be viewed from a new perspective.

**By Dr. Martin Gellender**  
Editor

The consensus of opinion was clear: the chemical industry will continue to rely upon petroleum and natural gas as the basic source of organic chemicals and fuel – at least for the next decade. After that, petroleum production will taper off, and the world must turn to alternative supplies of hydrocarbons. Only one alternate source could be developed in time, and on a sufficient scale to meet the impending shortfall. That source is coal. Other potential sources of chemicals and energy were discussed at the conference, but no one seriously proposed that the technology could be developed for application on a massive scale within 10–15 yrs.

In retrospect, it is now apparent that the extensive use of petroleum during our lifetime represents a short-term anomaly in human history. Within the last three decades, worldwide petroleum consumption has risen from relatively insignificant levels to the present 60 billion barrels per day. One-quarter of the world's original petroleum supply has now been exhausted. The average young man or woman will live through a period when heating, transportation and (to a much smaller extent) chemical production will have consumed about 80% of the world's reserves of conventional petroleum – petroleum produced by geologic processes operating during the last 600 million years.

The future of petroleum supplies might be even worse than implied by reserves and present consumption of petroleum. Growth of petroleum consumption *has* eased in industrialized nations, but much of the world's population in under-developed countries has expectations of a higher standard of living. Economic advancement in poor countries will almost certainly be accompanied by increased use of petroleum.

How has the outlook for world petroleum production changed since last July, when the

CHEMRAWN conference was held? Very little, according to Dr. M. King Hubbert (formerly of the US Geological Survey). Large discoveries of oil and natural gas have been reported in Southern Mexico, but many of these reports have been greatly exaggerated. Some reports quoted estimates of *total* oil-in-place as *recoverable* reserves, in one case providing an overstatement by a factor of 20. Several more years will probably be required before the extent of oil and gas reserves in Mexico is known with a reasonable degree of accuracy. Of course, it is impossible to predict future discoveries, but it seems likely that total ultimate production of oil will not greatly exceed the 200 billion barrels that has been estimated.

Furthermore, while present reserves of petroleum and natural gas are sufficient to ensure an adequate supply for the near-term, the reliability of supply is open to question. Most oil is concentrated in relatively few countries in the Middle East, Asia, North and South America. The recent political turmoil in Iran, one major oil-producing country, has demonstrated how vulnerable is the supply of oil to interruption by social and political factors within one country.

In the near-term, there is little alternative but to rely on conventional petroleum and natural gas. Long lead-times will be needed to develop new technology, optimize coal gasification and liquefaction processes, and build massive plants. Establishing a world-scale industry to make hydrocarbon fuels and chemicals from coal and other sources will require 15–20 yrs. Liquid hydrocarbons made from coal will not be as cheap as petroleum for some years, but the technology and hardware must be developed now to be ready in time.

Various new sources of fuels and chemicals will be developed – including oilsands and shales, wood, fast-growing plants, agricultural waste and solar energy.



Each of these will be developed by those countries with particularly favourable resources (for example, production of alcohol from sugar cane in Brazil). But on a global scale, coal emerges pre-eminent as a potential source of fuels and chemicals. There is sufficient coal available, and technology to use it can be optimized in time for widespread commercial application in the 1980's and 1990's. Known reserves are enough to supply world needs at least through the 21st century (and probably, longer). Coal can sustain the world economy with fuels, chemicals and nitrogen fertilizer while long-term development continues on nuclear fusion, solar energy and fast-growing plants. These renewable resources will be needed when supplies eventually become depleted.

It is likely that nuclear fusion will provide much of the world's energy requirements in the 21st century. The next few decades could mark the transition from the "age of petroleum" to the (much longer) "age of controlled nuclear fusion". The same nuclear reaction which yields the destruction of the hydrogen bomb could, if controlled, provide a virtually unlimited source of energy (with little accompanying radioactivity or environmental danger).

Since the CHEMRAWN conference, significant strides have been made in fusion research. In very recent experiments at Princeton University and Lawrence Livermore Laboratories, researchers have approached closer than ever before to the "break-even" condition (in which, the energy produced by the fusion reaction exceeds that required to heat and confine the deuterium/tritium plasma).

The conditions required for break-even are incredibly difficult to maintain. The plasma must be heated to about 100 million °K, and contained at a high density for a relatively long time (conditions are equivalent to a particle density normally found in gases at atmospheric pressure, for a period of 10  $\mu$ s). Break-even conditions have not yet been achieved in a controlled fusion reactor, but are expected to be reached in the mid-1980's. It could be attained in the £100 million reactor now under construction at Livermore Laboratories. In Europe, a fusion reactor termed "JET" (Joint European Torus) is being built in a cooperative venture by Britain, France and the Federal Republic of Germany. And Japan is also constructing a £100 million fusion test reactor.

Even if commercial fusion reactors are operating in the 21st century, a source of hydrocarbons will still be required by the chemical industry. True, electricity produced by fusion reactors could provide hydrogen for making ammonia-based fertilizer and for metallurgical reduction. But a source of carbon compounds will still be needed for manufacture of plastics, pharmaceuticals and fabrics. These will probably be provided by the coal liquefaction processes now under development.

Coal has been used as a fuel for more than 700 yr. About 1940, the gradual growth in coal demand was halted by conversion of industry (especially the chemical industry) and transportation facilities to petroleum. Oil was cheap, liquid and clean. Technology to convert coal to fuel gas, synthetic gasoline and chemicals progressed only in those countries that

## Global supply of recoverable hydrocarbons

Coal is clearly the hydrocarbon resource with the greatest remaining reserves. Estimates of recoverable coal resources vary over a sizeable range, but even the lowest estimate,  $2 \times 10^{12}$  metric tons, is ten times more than remaining petroleum reserves. However, each ton of bituminous coal has only half the energy content of the same weight of petroleum. Sub-bituminous and lignite coals have even lower specific energy.

Crude oil, unlike coal, has a short history of intensive use and will likely have a correspondingly short future. About half the crude oil reserves in the US and Canada have already been depleted, and output will soon decline. The US was the largest petroleum producer throughout the first half of this century. Up to 1950, nearly two-thirds of worldwide petroleum output came from the United States. As late as 1974, the US was still the world's leading oil-producing (and consuming) country. Since then, production has been exceeded by the Soviet Union and Saudi Arabia. Only about one-fifth of initial petroleum reserves have been tapped in these countries.

Enormous deposits of heavy oils, tarsands and shale

oils remain virtually untapped. But even with improved technology, only a small fraction of these hydrocarbons will probably be recovered. Host rock in which these hydrocarbons are found is generally 200–1000 m deep, and most deposits contain less than 3% hydrocarbons by weight. The hydrocarbons are difficult to extract from host rock, and have a high viscosity, high sulfur content, and impurities of vanadium and nickel. Preliminary upgrading is required to process the material into a synthetic crude oil which can be treated in conventional refineries. The Orinoco heavy oil belt in Venezuela now appears to be the world's largest deposit of petroleum, but the deposit is at depths of about 500 m and perhaps only 10% might be recoverable.

The accompanying table indicates how much coal, petroleum, natural gas and heavy oil is recoverable, and the area in which these resources are located. Estimates of recoverable resources are subject to a large margin of error, arising from uncertainty in the total amount of the deposits, and recovery yields. Data for this table was derived from the paper of M. K. Hubbert, presented at the 1978 CHEMRAWN conference.



feared isolation from petroleum supplies. During World War II, 22 coal liquefaction plants were built in Germany, producing 80 000 barrels/day of synthetic motor fuel. Other countries built coal liquefaction plants making about 30 000 barrels/day of synthetic liquid fuel from coal.

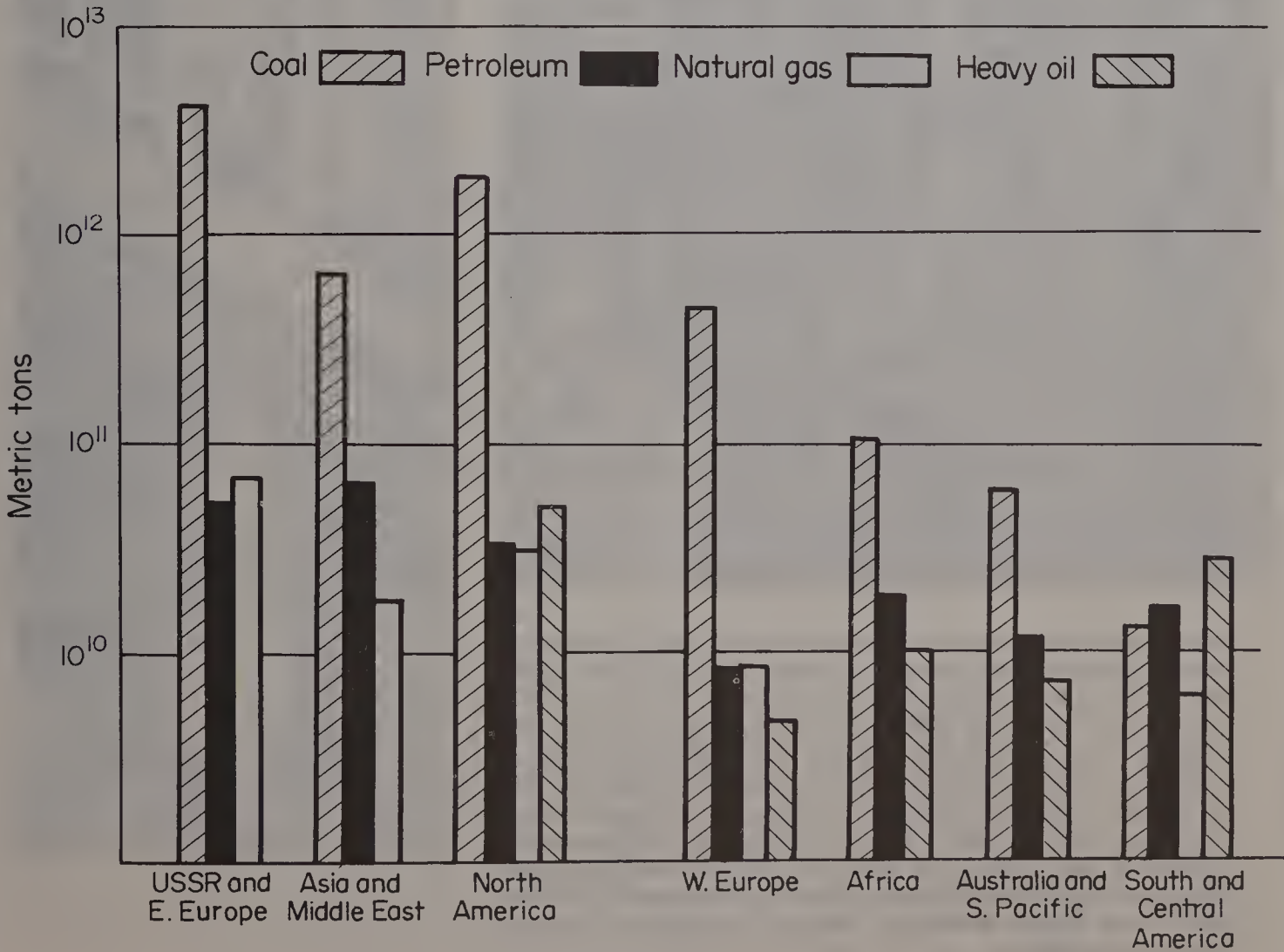
Liquid fuels from coal are still more expensive than oil, and will likely continue to cost more for years to come. Countries which have led in the development of coal gasification/liquefaction are those motivated by non-economic incentives. South Africa, seeking independence from external trade for strategic reasons, has developed a lead in coal liquefaction technology. The largest, and most efficient, coal liquefaction plant has recently begun operating in South Africa. Its capacity of 40 000 barrels/day can supply much of South Africa's present requirement for liquid fuels.

At the present state of development, all coal liquefaction processes suffer from low thermal efficiency. Typically, liquid hydrocarbon products have about 45% the heat energy, and 35% the weight, of the original coal feed. Most liquefaction processes cannot produce a few products selectively in good yield. Compared to conventional petroleum, liquefied coal contains a wider range of compounds, and a higher oxygen and nitrogen content. The nitrogen content may require the development and application of improved catalyst systems to prevent the emission of toxic nitrogen oxides. On the other hand, the high content of benzene and aromatic compounds in liquefied coal is

desirable in motor fuels and for chemical manufacture.

Although coal liquefaction needs improvement, it is basically a very old process. In fact, coal pyrolysis (to make coke and byproduct chemicals) is *the oldest* chemical process still in operation, having originated in 1584. The production of coke (consisting primarily of carbon) forms liquid byproducts with a much higher hydrogen/carbon ratio than is found in the coal feed. The hydrogen content of coal is also upgraded by two other methods presently being intensively developed: direct hydrogenation, and gasification (partial combustion) with oxygen, followed by condensation into hydrocarbons.

Gasification is the first step in several processes for making synthetic gasoline and chemicals. Coal is partially oxidized with oxygen and steam in a gasifier reactor, producing a mixture of carbon monoxide, hydrogen, and small amounts of hydrocarbon gases. This "syngas" can be treated and reacted to form methanol, a starting point for further chemical synthesis. Methanol can be converted directly into synthetic gasoline at low cost by deoxygenation with highly specific zeolite catalysts recently developed by Mobil Oil Company. Alternatively, syngas can be condensed into a mixture of liquid hydrogens by reaction on an iron catalyst at temperatures of 220–370°C and 10–40 atmospheres pressure. This is the Fischer–Tropsch process first invented by two German chemists in 1922. It is now the only coal liquefaction process in commercial use.





At present, gasification is the most costly step in coal liquefaction. Gasification is eliminated in direct hydrogenation processes undergoing active pilot-plant development in the US, UK and Germany. Ground coal is slurried in an organic solvent, and large aromatic polymer molecules are cracked and hydrogenated at high pressure with 400–500°C temperature. The product is a mixture of hydrocarbon gases, liquids, ash and unreacted coal. After separation by distillation, solvent is recycled back to the front-end of the process.

Several hydrogenation processes are under development, including the Exxon Donor Solvent Process, SRC-II, H-Coal and Modern German Process. These differ in choice of catalyst and reaction conditions. All consume large quantities of hydrogen gas. Some generate their own hydrogen requirements by gasifying solid residue (which may be more than half the weight of the coal feed).

Solvent extraction is yet another method of coal liquefaction. Hot solvent (or supercritical gas) at high temperature and pressure permeates the coal, depolymerizes large aromatic molecules, and extracts light hydrocarbons. The solvent can be a heavy oil produced from the coal itself. Supercritical gases, like

toluene vapor at 450°C and 200 atmospheres, have a lower viscosity than liquid solvents and readily penetrate into coal particles. After extraction of the coal, the low-boiling toluene can be readily flash vaporized from the product mix and recycled. Solvent and supercritical gas extraction are the main coal liquefaction methods under investigation by the National Coal Board in the UK. NCB now plans to go ahead with construction of two coal liquefaction pilot-plants. One, a £15 million plant, will produce 500 metric tons/h of coal-derived hydrocarbon liquids. Another £15 million plant will use supercritical gas solvent-extraction to produce about 1000 metric tons/h.

All the coal liquefaction processes now under development are likely to be improved considerably in efficiency, product characteristics and cost by further research and scale-up. Until coal liquefaction becomes competitive with petroleum, it will be largely the responsibility of governments to fund and encourage further development. The most efficient financing of research within industry might be the scheme suggested at the *CHEMRAWN* conference by Dr. D. S. Davies, chief scientist of the UK Dept. of Industry. He urged a two-pronged policy: the government pushing in funds



Liquid hydrocarbons are extracted from coal by supercritical gas extraction in this pilot plant in Stoke Orchard, UK. Coal feed (5–10 kg/h) is mixed with toluene (above). The slurry is then heated to about 400°C. At this temperature, toluene remains a vapor despite 100–200 atmospheres pressure inside the reactor tube (right). Here, supercritical toluene gas permeates into coal granules, cracks large hydrocarbon polymers, and extracts light hydrocarbons. Afterwards, toluene is flash vaporized from the mixture and recycled. The same process will be used in a much larger £15 million plant, now being designed. *Photos courtesy of the UK National Coal Board.*



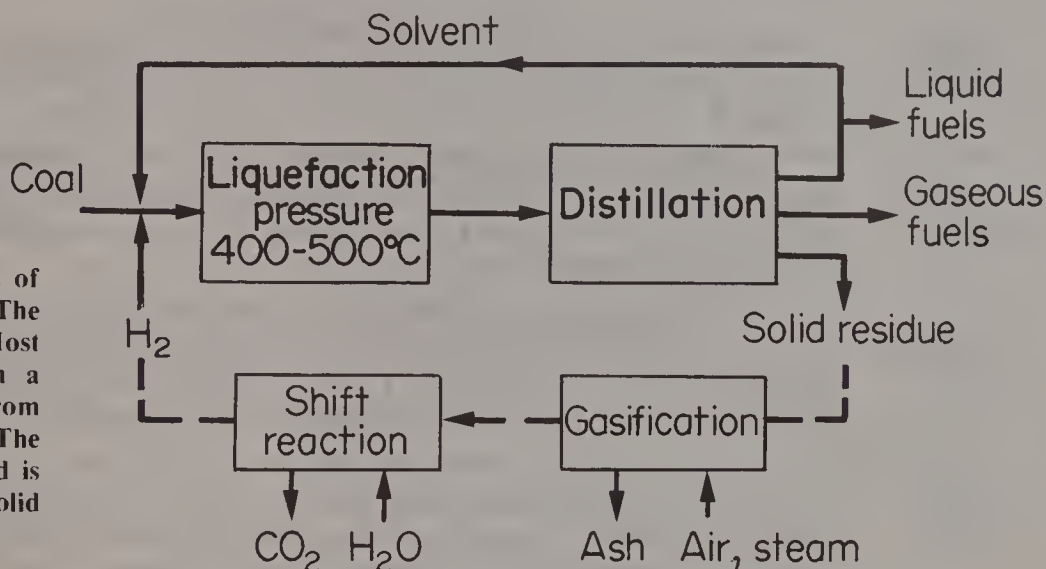


at the front (research) end, and pulling (buying) hydrocarbons at the production end.

The *CHEMRAWN* conference was an unusual technical meeting. As well as serving as an exchange of technology, it identified a clear course of action. Some proposals that were presented have been, at least partially accepted. The conference was probably unique as the largest gathering of technical experts who

considered the future of organic raw materials. Speakers and delegates attending the Toronto conference were a prestigious and influential cross-section of industry, university and government from 48 countries. The *CHEMRAWN* theme will be continued during a second conference, to be held in 1981, dealing with chemical aspects of agriculture and food supply.

Hydrogenation of coal is the basis of several coal liquefaction processes. The main features are depicted here. Most processes slurry the coal feed in a solvent, which is later recovered from the reaction products and recycled. The large amount of hydrogen required is sometimes generated by gasifying solid residue.



## What to do with *your* ideas

When you think of an interesting topic for an article in the *Information Bulletin*, don't wait. Write your ideas in a nearby notepad, or piece of clean, dry filter paper. Prepare a rough outline of the *main points* that you feel should be included in the article. Would you be prepared to write it, or do you know of someone who might? Perhaps you would be able to supply interesting photographs (most photographs can be interesting if used in the right context).

# CONFERENCES

IUPAC meetings are indicated in bold type  
Additional information from address in parenthesis

## 1979

### CHEMICAL APPARATUS

|               |                                                                                                                                                    |                    |
|---------------|----------------------------------------------------------------------------------------------------------------------------------------------------|--------------------|
| June<br>17-23 | ACHEMA 79, 19th Exhibition for Chemical Apparatus and Technology (DECHEMA, Postfach 970146, D-6000 Frankfurt/Main 97, Federal Republic of Germany) | Frankfurt<br>(FRG) |
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### SULFUR COMPOUNDS—NATURALLY OCCURRING

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| June<br>18-21 | Symposium on Low Molecular Weight Sulfur Compounds of Natural Occurrence (Dr. D. CAVALLINI, Istituto di Chimia Biologica, Citta Universitaria, I-00185 Rome, Italy) | Rome<br>(Italy) |
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### SURFACE PHENOMENA IN COLLOIDS

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|--------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------|
| June 24-<br>July 3 | 5th International Summer Conference "Chemistry of Solid/Liquid Interfaces" (Dr. V. PRAVDIC, Centre for Marine Research, Rudjer Boskovic Institute, POB 1016 YU-41001 Zagreb, Yugoslavia) | Cavtat, Dubrovnik<br>(Yugoslavia) |
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### NMR

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|---------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------|
| June<br>26-29 | 4th European Experimental NMR Conference. Conference languages will be French and English (M. Pierre SERVOZ-GAVIN, 4th EENC, Section de Résonance Magnétique, Centre d'Etudes Nucleaires de Grenoble, 85X, F-38041 Grenoble Cedex, France) | Austrans,<br>near Grenoble<br>(France) |
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### SPECTROSCOPY

|             |                                                                                                                                                                    |                   |
|-------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|
| July<br>1-6 | XXI Colloquium Spectroscopicum Internationale (Mr. K. M. BILLS, European Research and Development Centre, Inco Europe Ltd., Wiggin Street, Birmingham B16 0AJ, UK) | Cambridge<br>(UK) |
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### MODIFIED POLYMERS

|             |                                                                                                                                                                 |                                |
|-------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------|
| July<br>2-5 | 5th Conference on Modified Polymers, Their Preparation and Properties (Dr. A. ROMANOV, Slovak Academy of Sciences, Dubravska Cesta, Bratislava, Czechoslovakia) | Bratislava<br>(Czechoslovakia) |
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### CHROMATOGRAPHY

|             |                                                                                                                                          |                      |
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| July<br>5-6 | 2nd World Chromatography Conference (Vijay Mohan BHATNAGAR, Alena Enterprises of Canada, PO Box 1779, Cornwall, Ontario K6H 5VT, Canada) | Lisbon<br>(Portugal) |
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### BIOCHEMISTRY

|              |                                                                                                                                                                                                  |                     |
|--------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|
| July<br>8-14 | 11th International Congress of Biochemistry (R. W. DOLAN, Executive Secretary, XIth International Congress of Biochemistry, c/o Nat. Research Council of Canada, Ottawa, Ontario Canada K-A OR6) | Toronto<br>(Canada) |
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### DEGRADATION/STABILIZATION OF POLYMERS

|              |                                                                                                                                                                                                                                    |                            |
|--------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------|
| July<br>9-12 | 19th Prague Microsymposium on Macromolecules: Mechanisms of Degradation and Stabilization of Hydrocarbon Polymers (Dr. P. CEFELIN, PMM Secretariat, Institute of Macromolecular Chemistry, 1888 Petriny, Prague 6, Czechoslovakia) | Prague<br>(Czechoslovakia) |
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### SELENIUM AND TELLURIUM

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| July<br>9-12 | Third International Symposium on Organic Selenium and Tellurium Chemistry (Prof. Dr. D. CAGNIANT, Université de Metz, Faculté des Sciences, Laboratoire de Chimie Organique, Ile du Saulcy, F-5700 Metz, France) | Metz<br>(France) |
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### REACTIONS IN SOLUTION

|              |                                                                                                                                                        |                    |
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| July<br>9-13 | Second International Conference on Mechanisms of Reactions in Solution (Dr. John F. GIBSON, The Chemical Society, Burlington House, London W1V 0BN UK) | Canterbury<br>(UK) |
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### MICROCALORIMETRY OF MACROMOLECULES

|               |                                                                                                                                                                                                   |                            |
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| July<br>16-19 | 20th Prague Microsymposium on Macromolecules: Microcalorimetry of Macromolecules (Dr. P. CEFELIN, PMM Secretariat, Institute of Macromolecular Chemistry, 1888 Petriny, Prague 6, Czechoslovakia) | Prague<br>(Czechoslovakia) |
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## CONFERENCES 1979

### MOLECULAR ENERGY TRANSFER

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|---------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|
| July<br>16-20 | Sixth Conference on Molecular Energy Transfer (Mme. HUETZ – AUBERT, CNRS Groupe de Recherches Thermique, Ecole Centrale des Arts et Manufactures, Grand Voie des Vignes, F-92290 Chateney-Malabry, France) | Lioujas<br>(France) |
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### ORGANIC SYNTHESIS

- |               |                                                                                                                                                     |                   |
|---------------|-----------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|
| July<br>23-26 | 6th International Symposium on Synthesis in Organic Chemistry (Dr. Malcolm D. ROBINSON, The Chemical Society, Burlington House, London W1V 0BN, UK) | Cambridge<br>(UK) |
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### WEAK MOLECULES

- |               |                                                                                                                               |                    |
|---------------|-------------------------------------------------------------------------------------------------------------------------------|--------------------|
| August<br>1-3 | International Conference on Weak Molecules (Prof. P. A. KERWIN, Universite Laval, Cite Universitaire, Quebec, Canada G1K 7P4) | Quebec<br>(Canada) |
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### INTERSTELLAR MOLECULES

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|----------------|-----------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------|
| August<br>6-10 | Meeting sponsored by Int'l. Astronomical Union (Prof. P. A. WAYMAN, IAU Asst Sec. Gen., Dunsink Observatory, Castleknock, C. Dublin, Ireland) | Mont Tremblant,<br>Quebec<br>(Canada) |
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### MASS SPECTROMETRY

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|-----------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------|
| August<br>12-18 | 8th International Mass Spectrometry Conference (Dr. O. H. J. CHRISTIE, Laboratory for Mass Spectrometry, University of Oslo, PB 1048 Blindern, Oslo 3, Norway) | Oslo<br>(Norway) |
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### HETEROCYCLIC CHEMISTRY

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|-----------------|---------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------|
| August<br>12-17 | 7th International Congress of Heterocyclic Chemistry (Dr. S. W. SCHNELLER, Dept. of Chemistry, University of South Florida, Tampa, FL 33620, USA) | Tampa, Florida<br>(USA) |
|-----------------|---------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------|

### CRYSTALLOGRAPHY

- |                 |                                                                                                                           |                         |
|-----------------|---------------------------------------------------------------------------------------------------------------------------|-------------------------|
| August<br>13-17 | Fifth European Crystallographic Meeting (ECM-5, c/o DIS Congress Service, Knabrodstrede 3, DK-1210 Copenhagen K, Denmark) | Copenhagen<br>(Denmark) |
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### CATALYSIS

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|-----------------|------------------------------------------------------------------------------------------------------------------------------------------|--------------------|
| August<br>19-21 | 6th Canadian Symposium on Catalysis (Dr. R. RANGANATHAN, CANMET Energy Research Labs, 555 Booth Street, Ottawa, Ontario, Canada K1A 0G1) | Ottawa<br>(Canada) |
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### CHEMICAL EDUCATION

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|-----------------|---------------------------------------------------------------------------------------------------------|----------------------|
| August<br>20-23 | Chem Ed 79 (Dr. R. J. FRIESEN, Dept. of Chemistry, Univ. of Waterloo, Waterloo, Ontario N2L 3G1 Canada) | Waterloo<br>(Canada) |
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### ORGANIC CHEMISTRY

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|-----------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------|
| August<br>20-23 | 1st European Symposium of Organic Chemistry sponsored by West German Chemical Society and Federation of European Chemical Societies (Dr. W. FRITSCHKE, c/o Gesellschaft Deutscher Chemiker, P.O. Box 90 04 40, D-6000 Frankfurt/Main, Federal Republic of Germany) | Cologne<br>(FRG) |
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### ANALYTICAL CHEMISTRY

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|-----------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------|
| August<br>20-24 | 5th Australian Symposium on Analytical Chemistry (Dr. B. CODLING, Analytical Division, Royal Australian Chemical Institute, 39 Plain St., Perth, Western Australia 6000) | Perth<br>(Australia) |
|-----------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------|

### SURFACE AND COLLOID CHEMISTRY

- |                 |                                                                                                                                                                                         |                       |
|-----------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|
| AUGUST<br>20-25 | International Conference on Surface and Colloid Chemistry (Prof. S. FRIBERG, Department of Chemistry, 142 Chemistry Building, University of Missouri—Rolla, Rolla, Missouri 65401, USA) | Stockholm<br>(Sweden) |
|-----------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|

### CHEMICAL EDUCATION

- |                 |                                                                                                                                                |                     |
|-----------------|------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|
| August<br>27-31 | 3rd International Conference on Chemical Education (Mr. P. A. START, Department of Chemistry, University College, Belfield, Dublin 4, Ireland) | Dublin<br>(Ireland) |
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### ENGINEERING AND FOOD

- |                 |                                                                                                                                                                     |                       |
|-----------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|
| August<br>27-31 | Second International Congress on Engineering and Food – European Federation of Chemical Engineering (Dr. J. LARINKARI, P.O. Box 244, SF-00131 Helsinki 13, Finland) | Helsinki<br>(Finland) |
|-----------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|

**PLASMA CHEMISTRY**

- |                           |                                                                                                                                                                              |                         |
|---------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------|
| August 27–<br>September 1 | 4th International Symposium on Plasma Chemistry (Dr. S. VEPREK, Anorganisch-Chemisches Institut der Universität Zürich, Winterthurestrasse 190, CH-8057 Zürich, Switzerland) | Zürich<br>(Switzerland) |
|                           | Round Table on Thermal Plasma Processing (Dr. B. WALDIE, Department of Chemical and Process Engineering, Heriot-Watt University, Chambers Street, Edinburgh, Scotland)       | Zürich<br>(Switzerland) |

**IUPAC CONGRESS**

- |                 |                                                                                                                                                                                   |                       |
|-----------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|
| August<br>27–31 | 27th IUPAC Congress (Dr. J. LARINKARI, Kemian Helsinki Keskusliito, POB 13028, Fabrianinkatu 7B, SF-00131 Helsinki 13, Finland)<br>Additional information provided in this issue. | Helsinki<br>(Finland) |
|-----------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|

**MYCOTOXINS AND PHYCOTOXINS**

- |                           |                                                                                                                                                                                                               |                           |
|---------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------|
| August 30–<br>September 1 | 4th International IUPAC Symposium on Mycotoxins and Phycotoxins (Prof. P. KROGH, Department of Veterinary Microbiology, School of Veterinary Medicine, Purdue University, West Lafayette, Indiana 47907, USA) | Lausanne<br>(Switzerland) |
|---------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------|

**AROMATICITY**

- |                  |                                                                                                                                                                            |                           |
|------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------|
| September<br>3–5 | International Symposium on Aromaticity (Dr. A. GRAOVAC, Ruder Boskovic Institute, POB 1016, YU-41001 Zagreb, Yugoslavia)<br>Additional information provided in this issue. | Dubrovnik<br>(Yugoslavia) |
|------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------|

**ASBESTOS**

- |                  |                                                                                                         |                  |
|------------------|---------------------------------------------------------------------------------------------------------|------------------|
| September<br>3–7 | 4th International Conference on Asbestos (B. LINCOLN, PO Box 22, Trafford Park, Manchester M17 1RU, UK) | Turin<br>(Italy) |
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**GLYCOCONJUGATES**

- |                  |                                                                                                                                                                                                              |               |
|------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|
| September<br>3–7 | 5th International Symposium on Glycoconjugates (Dr. R. SCHAUER, Biochemischer Institut Christian-Albrechte-Universität, Otto-Meyerhof Haus, Olhausenstrasse 40-60, D-2300 Kiel, Federal Republic of Germany) | Kiel<br>(FRG) |
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**NEUROBIOLOGY OF INSECTS**

- |                  |                                                                                                                                          |              |
|------------------|------------------------------------------------------------------------------------------------------------------------------------------|--------------|
| September<br>3–7 | Neurotox '79: International Symposium on Neurobiology of Insects (Society of Chemical Industry, 14 Belgrave Square, London SW1X 8PS, UK) | York<br>(UK) |
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**FLUORINE**

- |                  |                                                                                                                                                                                                                                    |                     |
|------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|
| September<br>3–7 | IXth International Symposium on Fluorine Chemistry (Dr. J. CHATELET, Secrétaire Général IXème Symposium International de Chimie du Fluor, CEN-SACLAY, Département de Génie Isotopique, B.P. No. 2, F-91190 GIF-sur-Yvette, France) | Avignon<br>(France) |
|------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|

**MOLECULAR SPECTROSCOPY**

- |                  |                                                                                                                                        |                         |
|------------------|----------------------------------------------------------------------------------------------------------------------------------------|-------------------------|
| September<br>3–7 | 14th European Congress on Molecular Spectroscopy (Dr. J. WENDENBURG, POB 90 04 40, D-6000 Frankfurt/Main, Federal Republic of Germany) | Frankfurt/Main<br>(FRG) |
|------------------|----------------------------------------------------------------------------------------------------------------------------------------|-------------------------|

**ORGANOMETALLIC CHEMISTRY**

- |                  |                                                                                                                                                                                                                              |                   |
|------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|
| September<br>3–7 | 9th International Conference on Organometallic Chemistry (Prof. P. TIROUFLET, Laboratoire de Polarographie Organique, Faculté des Sciences 'Gabriel', Université de Dijon, 6 Boulevard Gabriel, F-21000 Dijon Cédex, France) | Dijon<br>(France) |
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**PHOTOCHEMICAL EFFECTS IN FIBERS**

**GENERAL MEETING, AMER. CHEM. SOC.**

- |                   |                                                                                                                                                               |                          |
|-------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------|
| September<br>9–14 | Symposium on Photochemical Effects in Fibers 178th ACS National Meeting (I. HARDIN, Auburn University, Department of Consumer Affairs, Auburn, AL 36830, USA) | Washington D.C.<br>(USA) |
|-------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------|

**GERMAN CHEMICAL SOCIETY**

- |                    |                                                                                                                                          |                 |
|--------------------|------------------------------------------------------------------------------------------------------------------------------------------|-----------------|
| September<br>10–14 | General Meeting of the German Chemical Society (FRG) (Gesellschaft Deutscher Chemiker, P.O. Box 90 04 40, D-6000 Frankfurt/Main 90, FRG) | Berlin<br>(FRG) |
|--------------------|------------------------------------------------------------------------------------------------------------------------------------------|-----------------|

**CORRELATION ANALYSIS**

- |                    |                                                                                                                                                                                |                   |
|--------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|
| September<br>10–14 | EUCHEM Conference on Correlation Analysis in Organic Chemistry (Dr. S. CLEMENTI, Dipartimento di Chimica, Università di Perugia, Via Elce di Sotto, I-10-06100 Perugia, Italy) | Assisi<br>(Italy) |
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## CONFERENCES 1979

### FREE RADICALS

|                    |                                                                                                                             |                     |
|--------------------|-----------------------------------------------------------------------------------------------------------------------------|---------------------|
| September<br>10-14 | EUCHEM Conference on Organic Free Radicals (Dr. John F. GIBSON, The Chemical Society, Burlington House, London W1V 0BN, UK) | Cirencester<br>(UK) |
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### MOSSBAUER SPECTROSCOPY

|                    |                                                                                                                                                           |                          |
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| September<br>10-14 | International Conference on Mossbauer Spectroscopy (Dr. D. HANZEL, J. Stefan Institute, University of Ljubljana, POB 199, YU-61001 Ljubljana, Yugoslavia) | Portrose<br>(Yugoslavia) |
|--------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------|

### NUCLEAR QUADRUPOLE RESONANCE

|                    |                                                                                                                                                                             |                      |
|--------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------|
| September<br>10-15 | 5th International Symposium on Nuclear Quadrupole Resonance Spectroscopy (5th ISNQRS, Laboratoire de Chimie de Coordination du CNRS, BP 4142, 31030-Toulouse-Cedex, France) | Toulouse<br>(France) |
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### FLUID FLOW

|                    |                                                                                                                                                                                               |                            |
|--------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------|
| September<br>11-13 | International Conference on Flow Analysis (Secretary FY – Amsterdam Laboratory for Analytical Chemistry, University of Amsterdam, Nieuwe Achtergracht 166, N1-1018 WV Amsterdam, Netherlands) | Amsterdam<br>(Netherlands) |
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### NITROGEN FIXATION

|                    |                                                                                                                                                                                        |                |
|--------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------|
| September<br>17-19 | Meeting of the Phytochemical Society of Europe on Nitrogen Fixation (Dr. J. R. GALLON, Department of Biochemistry, University College of Swansea, Singleton Park, Swansea SA2 8PP, UK) | Sussex<br>(UK) |
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### MACROMOLECULES

|                    |                                                                                                                                                                                                                  |                |
|--------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------|
| September<br>17-21 | International Symposium on Macromolecules (Prof. R. C. SCHULZ, Organisch-Chemisches Institut, J.J. Becherweg 18-20, D-6500 Mainz, Federal Republic of Germany)<br>Additional information provided in this issue. | Mainz<br>(FRG) |
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### PHOSPHORUS

|                    |                                                                                                                                                                                                                                          |                |
|--------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------|
| September<br>17-21 | International Conference on Phosphorus Chemistry 1979 (Prof. G. KEIL, Akademie der Wissenschaften der DDR, Rudower Chaussee 5, GDR-1199 Berlin-Adlershof, German Democratic Republic).<br>Additional information provided in this issue. | Halle<br>(GDR) |
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### SPECTROSCOPY

|                    |                                                                                                                                  |                       |
|--------------------|----------------------------------------------------------------------------------------------------------------------------------|-----------------------|
| September<br>17-21 | "Informationstagung Spektroskopie" (Sekretariat des Vereins Österreichischer Chemiker, Eschen-Gachgasse 9, A-1010 Wien, Austria) | Salzburg<br>(Austria) |
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### FILTRATION

|                    |                                                                                            |                |
|--------------------|--------------------------------------------------------------------------------------------|----------------|
| September<br>18-20 | 2nd World Filtration Congress (Filtration Society, 1 Katherine Street, Croydon CR9 1LB UK) | London<br>(UK) |
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### HEAVY METALS

|                    |                                                                                                                                                            |                |
|--------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------|
| September<br>18-21 | Int'l. Conference on Management and Control of Heavy Metals in the Environment (Secretariat, CEP Consultants Ltd, 26 Albany Street, Edinburgh EH1 3HQ, UK) | London<br>(UK) |
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### AMINES AND AMMONIUM SALTS

|                    |                                                                                                                                                                                                                                             |                   |
|--------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|
| September<br>24-26 | International Symposium on Polymeric Amines and Ammonium Salts (Prof. E. J. GOETHALS, Institute of Organic Chemistry, Rijksuniversiteit Gent, Krijgslaan 271 (S.4), B-9000 Gent, Belgium)<br>Additional information provided in this issue. | Gent<br>(Belgium) |
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### METAL CLUSTERS – CATALYSIS AND PHOTOGRAPHY

|                    |                                                                                                                                                                                                                                                                                                  |                               |
|--------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------|
| September<br>24-28 | International Meeting of the Societe de Chimie physique on Growth and Properties of Metal Clusters Applications to Catalysis and the Photographic Process (Dr. Jean BOURDON, Chairman of the Organising Committee Societe de Chimie physique, 10, rue Vauquelin, F-75231 Paris Cedex 05, France) | Villeurbanne-Lyon<br>(France) |
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### ORGANIZATION OF MACROMOLECULES

|                    |                                                                                                                                                                                    |                   |
|--------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|
| September<br>25-27 | Organization of Macromolecules in the Condensed Phase – General Discussion No. 68. (Mrs. Y. A. FISH, Faraday Division, The Chemical Society, Burlington House, London W1V 0BN, UK) | Cambridge<br>(UK) |
|--------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|

### PHOSPHORUS BIOCHEMISTRY

|                    |                                                                                                                                                                                                         |                  |
|--------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------|
| September<br>25-28 | International Symposium on Phosphorus Chemistry directed towards Biology (Prof. J. MICHALSKI, Centrum Baden, Molekularnych i Makromolekularnych Polska Akademii Nauk, Bocyna 5, PL-90 362 Lodz, Poland) | Lodz<br>(Poland) |
|--------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------|

EUROPEAN CHEMICAL ENGINEERING

|                    |                                                                                                                                                                                             |                   |
|--------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|
| September<br>26-28 | 219th Event of the European Federation of Chemical Engineering (Dr. K. SCHIEFER, VDI-Gesellschaft Verfahrenstechnik und Chemieingenieurwesen GVC, Postfach 11 39, D-4000 Dusseldorf 1, FRG) | Nurnberg<br>(FRG) |
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CHEMICAL ENGINEERING

|                            |                                                                                                                                                              |                    |
|----------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------|
| September 30-<br>October 3 | 29th Canadian Chemical Engineering Conference (Dr. J. Changfoot, Esso Chemical Canada, Plastics Technology Lab, P.O. Box 69, Sarnia, Ontario N7T 7H8 Canada) | Sarnia<br>(Canada) |
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ELECTROCHEMISTRY

|                |                                                                                                                                         |                           |
|----------------|-----------------------------------------------------------------------------------------------------------------------------------------|---------------------------|
| October<br>4-5 | "Angewandte Elektrochemie" (Gesellschaft Deutscher Chemiker, Abteilung Fachgruppen, Postfach 90 04 40, D-6000 Frankfurt (Main) 90, FRG) | Frankfurt-Hochst<br>(FRG) |
|----------------|-----------------------------------------------------------------------------------------------------------------------------------------|---------------------------|

WATER POLLUTION CONTROL

|                 |                                                                                                                        |                  |
|-----------------|------------------------------------------------------------------------------------------------------------------------|------------------|
| October<br>7-12 | Water Pollution Control Federation International Convention (R. A. CANHAM, 3900 Wisconsin St. Chicago, ILL 60606, USA) | Houston<br>(USA) |
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ANALYTICAL CHEM. IN ENERGY TECHNOLOGY

|                 |                                                                                                                                                             |                            |
|-----------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------|
| October<br>9-11 | 23rd ORNL Conference on Analytical Chemistry on Energy Technology (Dr. W. S. LYON Jr., Oak Ridge National Laboratory, P.O. Box X, Oak Ridge, TN 37830, USA) | Gatlinburg, Tenn.<br>(USA) |
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CLINICAL BIOCHEMISTRY

|                  |                                                                                                                                                                                                                 |           |
|------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|
| October<br>14-19 | 1st South East Asian and Pacific Congress of Clinical Biochemistry (1st SEAP Congress of Clinical Biochemistry, Singapore Professional Centre, 129 B Block 23, Outram Park, Singapore 3, Republic of Singapore) | Singapore |
|------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|

LABORATORY EQUIPMENT

|                  |                                                                                                                                                                                           |                   |
|------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|
| October<br>17-20 | International Exhibition on Laboratory Technology Analyses, Procedures and Automation in Chemistry (Media Consult GmbH, Conventions and Exhibitions, P.O. Box 404, A-1171, Wien, Austria) | Graz<br>(Austria) |
|------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|

CHROMATOGRAPHY

|                  |                                                                                                                                           |                       |
|------------------|-------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|
| October<br>21-24 | 18th ASTM Annual Meeting on the Practice of Chromatography (Dr. T. BRADLEY, Spectra-Physics, 2905 Stender Way, Santa Clara, CA 95051 USA) | Philadelphia<br>(USA) |
|------------------|-------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|

RECLAMATION OF CONTAMINATED LAND

|                  |                                                                                                                                                |                    |
|------------------|------------------------------------------------------------------------------------------------------------------------------------------------|--------------------|
| October<br>22-25 | Reclamation of Contaminated Land (Miss J. BOVIER, Conference Secretary, Society of Chemical Industry, 14 Belgrave Square, London SW1X 8PS, UK) | Eastbourne<br>(UK) |
|------------------|------------------------------------------------------------------------------------------------------------------------------------------------|--------------------|

LIQUID CHROMATOGRAPHY

|                  |                                                                                                                          |                        |
|------------------|--------------------------------------------------------------------------------------------------------------------------|------------------------|
| October<br>24-25 | International Liquid Chromatography Symposium (Dr. J. Cazes, Waters Associates, 34 Maple Street, Milford, MA 01757, USA) | Strasbourg<br>(France) |
|------------------|--------------------------------------------------------------------------------------------------------------------------|------------------------|

QUANTUM CHEMISTRY

|                           |                                                                                                                                                                                                                                  |                  |
|---------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------|
| October 29-<br>November 3 | Third International Congress of Quantum Chemistry (Prof. Teijiro YONEZAWA, Secretary General, Third International Congress of Quantum Chemistry, c/o Kyoto International Conference Hall, Takaraike, Sakyo-ku, Kyoto, Japan 606) | Kyoto<br>(Japan) |
|---------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------|

NON-DESTRUCTIVE TESTING

|                   |                                                                                                                     |                          |
|-------------------|---------------------------------------------------------------------------------------------------------------------|--------------------------|
| November<br>18-23 | 9th World Conference on Non-destructive Testing (R. B. OKE, NATA 191 Royal Parade, Parkville, Vic. 3052, Australia) | Melbourne<br>(Australia) |
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NUCLEAR SAFEGUARDS

|                   |                                                                                                                                                                                |                           |
|-------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------|
| November<br>26-29 | American Nuclear Society Conference on "Measurement Technology for Safeguards and Materials Control" (T. CANADA, Los Alamos Scientific Lab, MS-540, Los Alamos, NM 87544, USA) | Charleston, S.C.<br>(USA) |
|-------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------|

HYDROCARBON CHEMISTRY

|                   |                                                                                                                                                                                                                        |                      |
|-------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------|
| December<br>10-11 | International Symposium on New Horizons in Hydrocarbon Chemistry (Prof. L. M. STEPHENSON, The Institute of Hydrocarbon Chemistry, Science Hall 101, The University of Southern California, Los Angeles, CA 90007, USA) | Los Angeles<br>(USA) |
|-------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------|



## CONFERENCES 1979/80

### ALTERNATE ENERGY SOURCES

- |                   |                                                                                                                                                                                    |                          |
|-------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------|
| December<br>10-12 | 2nd Miami Int'l Conference on Alternative Energy Sources (Dr. T. N. VEZIROGLU, Clean Energy Research Institute, University of Miami, P.O. Box 248294, Coral Gables, FL 33124, USA) | Miami Beach, FL<br>(USA) |
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### COORDINATION CHEMISTRY

- |                   |                                                                                                                                                                                                                                      |                     |
|-------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|
| December<br>10-14 | 20th International Conference on Coordination Chemistry (Prof. D. BANERJEA, Convener XX-ICCC, Indian Chemical Society, 92 Acharyya Prafulla Chandra Road, Calcutta 700 009, India)<br>Additional information provided in this issue. | Calcutta<br>(India) |
|-------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|

## 1980

### INDUSTRIAL WASTE

- |                 |                                                                                                                                                                                           |                       |
|-----------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|
| February<br>7-9 | 3rd International Congress on Industrial Waste Water and Wastes (Mr. B. GÖRANSSON, Institutet för Vatten-och Luftvårdsforskning, POB 21060, Hålsingegatan 43, S-100 31 Stockholm, Sweden) | Stockholm<br>(Sweden) |
|-----------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|

### DEGRADATION OF ORGANIC COATINGS

- |              |                                                                                                                                                                                     |                  |
|--------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------|
| March<br>3-7 | Symposium on Photodegradation, Photo-oxidation and Photostabilization of Organic Coatings 179th ACS National Meeting (F. H. WINSLOW, Bell Laboratories, Murray Hill, NJ 07974, USA) | Houston<br>(USA) |
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### AMERICAN CHEMICAL SOCIETY

- |                |                                                                                                   |                    |
|----------------|---------------------------------------------------------------------------------------------------|--------------------|
| March<br>23-28 | ACS - Spring - Meeting (American Chemical Society, 1155 16 Street NW, Washington D.C. 20036, USA) | (Houston)<br>(USA) |
|----------------|---------------------------------------------------------------------------------------------------|--------------------|

### CHEMICAL REACTION ENGINEERING

- |                |                                                                                                                                                                                        |                  |
|----------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------|
| March<br>25-27 | 6th International Symposium on Chemical Reaction Engineering (Prof. Jacques VILLERMAUX, Laboratoire des Sciences du Genie Chimique, CNRS-ENSIC, 1 rue Grandville, 54042-Nancy, France) | Nice<br>(France) |
|----------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------|

### PHASE TRANSITIONS IN MOLECULAR SOLIDS

- |                |                                                                               |                |
|----------------|-------------------------------------------------------------------------------|----------------|
| March<br>26-28 | (Faraday Division, UK Chemical Society, Burlington House, London W1V 0BN, UK) | Exeter<br>(UK) |
|----------------|-------------------------------------------------------------------------------|----------------|

### PLASMA PHYSICS

- |               |                                                                                                                                |                            |
|---------------|--------------------------------------------------------------------------------------------------------------------------------|----------------------------|
| April<br>7-11 | International Conference of Plasma Physics (K. NISHIKAWA, Institute for Fusion Theory, Hiroshima University, Hiroshima, Japan) | Tokyo or Nagoyo<br>(Japan) |
|---------------|--------------------------------------------------------------------------------------------------------------------------------|----------------------------|

### SURFACE COATINGS & SURFACE TREATMENT

- |               |                                                                                  |                |
|---------------|----------------------------------------------------------------------------------|----------------|
| April<br>9-11 | (Industrial Division, UK Chemical Society, Burlington House, London W1V 0BN, UK) | Durham<br>(UK) |
|---------------|----------------------------------------------------------------------------------|----------------|

### CHEMICAL ENGINEERING

- |                |                                                                                                                                                                                |                         |
|----------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------|
| April<br>14-16 | 5th International Scandinavian Congress of Chemical Engineering - European Federation of Chemical Engineering (Bella Center A/S, Center Boulevard, 2300 Copenhagen S, Denmark) | Copenhagen<br>(Denmark) |
|----------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------|

### NON-METALS IN METALS

- |              |                                                                                                                           |                 |
|--------------|---------------------------------------------------------------------------------------------------------------------------|-----------------|
| May<br>10-13 | Non-Metals in Metals (Gesellschaft Deutscher Chemiker, Abt. Fachgruppen, Postfach 900440 D-6000 Frankfurt (Main) 90, FRG) | Berlin<br>(FRG) |
|--------------|---------------------------------------------------------------------------------------------------------------------------|-----------------|

### PHOSPHORUS COMPOUNDS

- |              |                                                                                                            |       |
|--------------|------------------------------------------------------------------------------------------------------------|-------|
| April<br>May | Second International Congress on Phosphorus Compounds (IMPHOS-8, rue de Penthièvre, F-75008 Paris, France) | (USA) |
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### GENERAL MEETING ANZAAS

- |              |                                                                                                                                                        |                         |
|--------------|--------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------|
| May<br>12-16 | 50th Congress of the Australian and New Zealand Association for Advancement of Science (Dr. J. R. BEST, 141 Rundle Mall, Adelaide, SA 5000, Australia) | Adelaide<br>(Australia) |
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### SOLUTE-SOLVENT INTERACTIONS

- |             |                                                                                                                                                                                                                                                                                    |                     |
|-------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|
| June<br>2-6 | 5th International Symposium on Solute-Solute-Solvent Interactions (Prof. I. BERTINI, Faculta di Farmacia, Istituto di Chimica Generale e Inorganica, Università degli Studi di Firenze, Via Gino Capponi 7, I-50121 Firenze, Italy) Additional information provided in this issue. | Florence<br>(Italy) |
|-------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|

### ZEOLITES

- |             |                                                                                                                                                           |                   |
|-------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|
| June<br>2-6 | 5th International Conference on Zeolites (Prof. R. SERSALE, Istituto di Chimica Applicata, Università di Napoli, Piazzale Tecchio, I-80125 Napoli, Italy) | Naples<br>(Italy) |
|-------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|

## CONFERENCES 1980

### POLYVINYL CHLORIDE

- |      |                                                                                                                                               |                      |
|------|-----------------------------------------------------------------------------------------------------------------------------------------------|----------------------|
| June | 3rd International Symposium on Polyvinyl Chloride (Dr. E. A. COLLINS, Diamond Shamrock Corporation, P.O. Box 348, Painesville, OH 44077, USA) | Cleveland/Ohio (USA) |
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### PARTICLE TECHNOLOGY IN CHEMICAL ENGINEERING

- |          |                                                                                                                                                                                          |                         |
|----------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------|
| June 3-5 | Symposium on Particle-Technology – European Federation of Chemical Engineering (Ir. M. A. G. VORSTMAN, TH Eindhoven, afd. VAK Gr. Fys. Technologie, Postbus 513, Eindhoven, Netherlands) | Amsterdam (Netherlands) |
|----------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------|

### TEXTILE DYES

- |          |                                                                                           |                   |
|----------|-------------------------------------------------------------------------------------------|-------------------|
| June 5-6 | HV der Vereins der Textilchemiker (VTCC, Rohrbacher Strasse 76, D-6900 Heidelberg 1, FRG) | Baden-Baden (FRG) |
|----------|-------------------------------------------------------------------------------------------|-------------------|

### ORGANIC SYNTHESIS

- |            |                                                                                                                                                                        |                          |
|------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------|
| June 15-20 | 3rd IUPAC Symposium on Organic Synthesis (Prof. B. M. TROST, Department of Chemistry, University of Wisconsin-Madison, 1101 University Avenue, Madison, WI 53706, USA) | Madison, Wisconsin (USA) |
|------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------|

### B-LACTAM ANTIBIOTICS

- |                |                                                                                  |                |
|----------------|----------------------------------------------------------------------------------|----------------|
| June 30-July 3 | (Industrial Division, UK Chemical Society, Burlington House, London W1V 0BN, UK) | Cambridge (UK) |
|----------------|----------------------------------------------------------------------------------|----------------|

### CATALYSIS

- |                |                                                                                                                                                                                                                    |               |
|----------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|
| June 30-July 4 | 7th International Congress on Catalysis (Prof. I. YASUMORI, Department of Chemistry, Tokyo Institute of Technology, 2-21-1 Ookayama, Megmo-ku, Tokyo 152, Japan)<br>Additional information provided in this issue. | Tokyo (Japan) |
|----------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|

### THERMAL ANALYSIS

- |           |                                                                                                         |                |
|-----------|---------------------------------------------------------------------------------------------------------|----------------|
| July 6-12 | 6th International Conference on Thermal Analysis (6th ICTA '80 P.O. Box 1120, D-8672 Selb/Bavaria, FRG) | Bayreuth (FRG) |
|-----------|---------------------------------------------------------------------------------------------------------|----------------|

### CARBOHYDRATE CHEMISTRY

- |           |                                                                                                                                                                                                                                            |                    |
|-----------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------|
| July 7-11 | 10th International Symposium on Carbohydrate Chemistry (Prof. S. J. ANGYAL, School of Chemistry, University of New South Wales, P.O. Box 1, Kensington, New South Wales 2033, Australia)<br>Additional information provided in this issue. | Sydney (Australia) |
|-----------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------|

### ANALYTICAL CHEMISTRY

- |            |                                                                                                                                                             |                |
|------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------|
| July 20-26 | SAC 80: International Conference on Analytical Chemistry (Dr. J. D. R. THOMAS, Department of Chemistry, UWIST, King Edward VII Avenue, Cardiff CF1 3NU, UK) | Lancaster (UK) |
|------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------|

### FERMENTATION

- |            |                                                                                                                                                              |                          |
|------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------|
| July 20-27 | 6th International Fermentation Symposium (Prof. J. E. ŽAJIC, Faculty of Engineering Science, University of Western Ontario, London, Ontario, Canada N6A 5B9) | London, Ontario (Canada) |
|------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------|

### GERMANIUM, TIN AND LEAD

- |            |                                                                                                                                                                                                     |                |
|------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------|
| July 21-25 | 3rd International Conference on the Organometallic and Coordination Chemistry of Germanium, Tin and Lead (Dr. J. F. GIBSON, The Chemical Society, Burlington House, Piccadilly, London W1V 0BN, UK) | Dortmund (FRG) |
|------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------|

### PHYSICAL ORGANIC CHEMISTRY

- |              |                                                                                                                                                                |                              |
|--------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------|
| August 17-22 | 5th IUPAC Conference on Physical Organic Chemistry (Prof. J. F. BUNNETT, Division of Natural Sciences-II, University of California, Santa Cruz, CA 95064, USA) | Santa Cruz, California (USA) |
|--------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------|

### GENERAL MEETING, NORTH AMERICA

- |              |                                                                                                                                                    |                     |
|--------------|----------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|
| August 24-29 | 2nd Chemical Congress of the North American Continent (A. T. WINSTEAD, American Chemical Society, 1155 16th Street NW, Washington D.C. 20036, USA) | San Francisco (USA) |
|--------------|----------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|

### OZONE

- |        |                                                                                                                                                                                          |                         |
|--------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------|
| August | Symposium sponsored by International Association of Meteorology and Atmospheric Physics, WMO and COSPAR (Mr. S. RUTTENBERG, Secretary IAMAP NCAR, P.O. Box 3000, Boulder, CO 80307, USA) | Boulder, Colorado (USA) |
|--------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------|

### ANALYTICAL CHEMISTRY

- |               |                                                                                                                                                                                                 |                 |
|---------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|
| September 1-5 | 5th Polish Conference on Analytical Chemistry (Prof. A. HULANICKI, Instytut Podstawowych, Problemow Chemii, Wydział Chemii, Uniwersytet Warszawski, U1. Pasteura 1, PL-02 093 Warszawa, Poland) | Warsaw (Poland) |
|---------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|



## CONFERENCES 1980/81

### COMPUTERS IN CHEMICAL ENGINEERING

- |                  |                                                                                                                                                                                                                                        |                    |
|------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------|
| September<br>2-5 | Chemplant '80 – Symposium of the Working Party on Routine Calculations and Use of Computers in Chemical Engineering – European Federation of Chemical Engineering (Hungarian Chemical Society, Anker Kőz 1, 1061 Budapest VI, Hungary) | Heviz<br>(Hungary) |
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### MACROMOLECULES

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| September<br>7-13 | International Symposium on Macromolecules (Prof. F. CIARDELLI, Istituto Chimica Organica Industriale, Via Risorgimento 35, I-56100 Pisa, Italy) | Florence<br>(Italy) |
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### PHOTOELECTROCHEMISTRY

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| September<br>8-10 | (Faraday Division, UK Chemical Society, Burlington House, London W1V 0BN, UK) | Oxford<br>(UK) |
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### SAFETY IN PROCESS INDUSTRIES

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| September<br>15-19 | 3rd International Symposium on Loss Prevention and Safety Promotion in the Process Industries – European Federation of Chemical Engineering (3rd Intern. Symp. on Loss Prevention and Safety Promotion in the Process Industries, P.O. Box 141, 4007 Basle, Switzerland) | Basle<br>(Switzerland) |
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### NON-AQUEOUS COLLOIDAL DISPERSIONS

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|--------------------|-------------------------------------------------------------------------------|-------------------|
| September<br>16-18 | (Faraday Division, UK Chemical Society, Burlington House, London W1V 0BN, UK) | Edinburgh<br>(UK) |
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### COSMETIC RESEARCH

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| September<br>22-25 | 11th International Congress on Cosmetic Research and Technology (Conventions Service Italy, Piazza Mignarelli 4, 00187 Rome, Italy) | Venice<br>(Italy) |
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### WATER POLLUTION CONTROL

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| September 28-<br>October 3 | Water Pollution Control Federation International Convention (R. A. CANHAM, 3900 Wisconsin Avenue, NW., Washington D.C. 20016, USA) | Atlantic City, N.J.<br>(USA) |
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### MODERN RADIOCHEMICAL PRACTICE

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| September 29-<br>October 3 | (Analytical Division, UK Chemical Society, Burlington House, London W1V 0BN, UK) | York<br>(UK) |
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### CATALYST DEACTIVATION

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| October<br>13-15 | International Symposium on Catalyst Deactivation: Poisoning, Coke formation, Solid state chemical transformations (Prof. B. DELMON, Universite Catholique de Louvain, Group de Physico-Chemie Minerale et de Catalyse, Place Croix du Sud 1, 1348 Louvain-La-Neuve, Belgium) | Antwerp<br>(Belgium) |
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### SCIENTIFIC INFORMATION TRANSFER

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| October<br>13-17 | 2nd International Conference of Scientific Editors (Helena TOMBAL, Elsevier Scientific Publishing Co., P.O. Box 330, 1000 AH Amsterdam, The Netherlands) | Amsterdam<br>(Netherlands) |
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## 1981

### NMR

- |               |                                                                                                           |                |
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| July<br>12-17 | 5th International Meeting on NMR Spectroscopy (UK Chemical Society, Burlington House, London W1V 0BN, UK) | Exeter<br>(UK) |
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### PLATINIUM GROUP METALS

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|---------------|-------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|
| July<br>19-24 | International Conference on the Chemistry of Platinum Group Metals (Dr. P. L. GOGGIN, School of Chemistry, The University, Bristol BS8 1TS, UK) | Bristol<br>(UK) |
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### ORGANIC SYNTHESIS

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| July<br>20-23 | 7th International Symposia on Synthesis in Organic Chemistry (UK Chemical Society, Burlington House, London W1V 0BN, UK) | Oxford<br>(UK) |
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### AMERICAN CHEMICAL SOCIETY

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|-----------------|-----------------------------------------------------------------------------------------------|------------------------|
| August<br>23-28 | ACS-FALL-MEETING (American Chemical Society, 1155 16th Street NW, Washington D.C. 20036, USA) | New York City<br>(USA) |
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### EUROANALYSIS

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| August<br>23-28 | FECS Conference Euroanalysis – IV (Prof. Lauri NIINISTO, Department of Chemistry, Helsinki University of Technology, 02150 Espoo 15, Finland) | Helsinki<br>(Finland) |
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### NONBENZENOID AROMATIC COMPOUNDS

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|--------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|
| August 30<br>September 4 | 4th International Symposium on Chemistry of Nonbenzoid Aromatic Compounds (Prof. I. AGRANAT, Department of Organic Chemistry, Hebrew University of Jerusalem, Jerusalem, Israel) | Jerusalem<br>(Israel) |
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## 27th IUPAC Congress

27–31 August 1979

Helsinki, Finland

In addition to six plenary lectures by prominent speakers, the programme is divided into six sections. Each session will consist of several invited lectures, and of short communications presented orally or as poster sessions. The programme consists of the following sections:

- (1) TRACE ELEMENT ANALYSIS
- (2) MODERN METHODS IN CLINICAL CHEMISTRY
- (3) ANALYSIS AND STRUCTURE OF CELL MEMBRANE CARBOHYDRATES
- (4) CHEMISTRY AND TECHNOLOGY OF NATURAL POLYMERS AND THEIR DEGRADATION PRODUCTS
- (5) BIOTECHNOLOGY AND BIOENGINEERING
- (6) CHEMOMETRICS (Chemical Data Handling and Analysis)

The conference will be located at the Finlandia Hall, situated near the Parliament House in the centre of the

city. Helsinki is accessible by frequent direct flights from many European cities, the USA and Japan, car ferries from the Fed. Rep. of Germany, Denmark, Sweden and Poland, and trains from the USSR.

**Sight-seeing and tours** to different parts of Finland can be organized before and after the Congress. There are good connections with other Scandinavian countries and the USSR for more extended tours.

The official language of the Congress is **English**. No simultaneous translation will be provided.

The **registration fee** for the Congress will be about 150 US dollars for participants, and 50 US dollars for students and accompanying persons.

**Abstracts** of all lectures and communications will be made available to registered participants before the Congress. Plenary lectures and invited lectures will be published afterwards in *Pure & Applied Chemistry*. Short communications will not be published by the Congress organizers.

Additional **information** can be obtained from: Dr. J. Larinkari, PO Box 244, SF-00131, Helsinki 13 Finland. Telephone: (3580) 17-44-15.

## International Symposium on Aromaticity

3–5 September 1979

Dubrovnik, Croatia, Yugoslavia

The aim of this symposium is to bring together experimental chemists (organic and physical) and theoretical chemists for discussions about aromaticity. The program will include invited papers presented in the morning sessions, followed by contributed papers in the afternoon.

The symposium will be held in the Hotel Libertas, situated on the coast near the old quarter of Dubrovnik. **Accommodation** is available at the Hotel Libertas, or at a less expensive rate, in the Hotel Lero about a five minute walk from the symposium.

Dubrovnik is an important town in the cultural and political history of Croatia. It is also of considerable architectural and historical interest, having existed for over a thousand years. The city is a popular holiday resort situated on the southern Adriatic coast.

An international airport connects Dubrovnik with Zagreb and Belgrade by daily flights.

The symposium language is **English**. Proceedings of the symposium are expected to be published as a special issue of *Croatica Chemica Acta*.

**Further information** can be obtained by writing to: International Symposium on Aromaticity, Institute Ruder Boskovic, POB 1016, 41001 Zagreb, Croatia, Yugoslavia.

## IUPAC 26th Int'l. Symposium on Macromolecules

17–21 September 1979

Mainz, F.R. Germany

The conference program will consist of plenary lectures, general lectures and short communications. Plenary lectures will be presented by P. J. Flory of the USA (*Molecular Structure, Conformation and Properties of Macromolecules*), and by G. Smets of Belgium (*New Developments and Future of Synthetic Polymer Chemistry*). General lectures will be presented in five sessions: (A) Synthesis, (B) Selected Topics in Polymer Chemistry, (C) Structure and Thermodynamics of Solutions, Gels and Polymer Mixtures, (D) Dynamics of Polymer Systems, (E) State of Order and Transitional Phenomena, and (F) Selected Properties and Applications of Polymers. In addition, there will be 200–300 short communications, each about 15 minutes long, presented in several parallel sessions.

All authors are encouraged to make their verbal presentation in **English**, although all IUPAC languages are permitted. No translation services will be provided.

Participants from some countries may need an **entry visa** for the Federal Republic of Germany. If a visa has not been granted one month before the meeting, the IUPAC secretariat should be notified by the applicant.

**Accommodation** will be provided in several price ranges at Verkehrsverein. A limited number of rooms may be available in student hostels.



MAINZ

# International Conference on Phosphorus Chemistry

17-21 September 1979  
Halle (Saale), German Democratic  
Republic

This conference will consider new results and recent developments in the synthesis, structure, reactivity, technical application and biological activity of phosphorus derivatives. The programme consists of plenary lectures (45 minutes), main lectures on each of the twelve topics (30 minutes and 5 minutes discussion), and contributed papers held in parallel sessions (15 minutes with 5 minutes discussion). About 150 contributed papers will be selected for presentation from those that have been submitted.

Official languages of the conference are English, Russian, German, and French (preferably English).

Abstracts of papers (in English only) will be provided to participants upon registration. Plenary and main lectures will be published after the conference in *Pure & Applied Chemistry*, and also as a specially bound reprint.

Visa applications should be requested from the nearest embassy of the German Democratic Republic. Entry visas will be granted to all participants who have applied to the appropriate authorities at least three months in advance of the conference. Special regulations apply to participants from the Federal Republic of Germany.

The registration fee will be 85 US dollars, and 35 US dollars for accompanying persons.

All participants of the conference are invited to attend the following social events free of charge: Concert of the Halle Madrigalists, Performance of the Haendel Opera, Visit of historical places of classical German literature in Weimar, and a banquet. Other half-day excursions, sightseeing tours and visits will be available to accompanying persons.

Correspondence for further information should be addressed to: Prof. Dr. K. Issleib, Martin Luther Universität, Sektion Chemie (ICPC '79), Weinbergweg 16, DDR-402 Halle/Saale. Telephone: 6333210.

The symposium will be held at the Congress Center situated adjacent to the town hall and the Mainz Hilton Hotel. This location is in the center of the city at the bank of the Rhein River.

The symposium cultural program will include visits to wine and champagne cellars and tours of the surrounding countryside. Tours of the city of Mainz will be organized through the old part of the city, the cathedral, the world museum of printing art, and the Roman-Germanic-Central-Museum.

The weather in Mainz in September is usually sunny and mild (average day-time temperature of 19-20°C), but it is advisable to bring a light coat and umbrella.

For further information, contact: Secretary General MAKRO MAINZ 1979, Dr. W. Fritsche, c/o Gesellschaft Deutscher Chemiker, P.O. Box 90 04 40, D-6000 Frankfurt/Main 90, Federal Republic of Germany. Telephone: (0611) 7-91-73-20.

Prepared texts of symposium papers will be provided to participants at the conference. Afterwards, plenary lectures will be published in *Pure & Applied Chemistry*, and general lectures will be published in a separate volume.



## *IUPAC International Symposium*

# ***Polymeric Amines & Ammonium Salts***

## ***Synthesis – Properties – Applications***

***24–26 September 1979***

***Ghent, Belgium***

This symposium will deal with synthesis, properties and applications of polymers containing amino or ammonium salt functional groups. Twelve main lectures are expected to be delivered by prominent researchers. Short communications will also be submitted by participants.

The **location** of the symposium will be at the Faculty of Sciences of the University of Ghent. The city of Ghent is located 50 km north-west of Brussels. Train connections with Brussels are excellent and many international trains stop in Ghent on their way to Ostend–London. Ghent is easily reached from Mainz by train or highway in about 5 hours.

All contributors are recommended to make their verbal presentation in **English**. No translation services will be provided.

**Accommodation** for participants will be arranged in hotels of various categories. In addition, comfortable student dormitory rooms will be available at reasonable rates. Additional information is provided in the second information circular.

**Reprints** of invited lectures and communications will be available at the Symposium.

In addition to the scientific programme, **social events** will be held. A ladies programme will include a visit to Bruges and the Belgian seaside. On Sunday afternoon, a guided tour through the city of Ghent will be organized. All participants will have the opportunity to attend a concert at the famous Festival of Flanders.

**Further information** can be obtained from Prof. E. Goethals, Institute of Organic Chemistry, University of Ghent, Krijgslaan 271 (S4), B-9000 Belgium. Telephone: 091/22 57 15.

## ***20th International Conference on***

# ***Coordination Chemistry***

***10–14 December 1979***

***Calcutta, India***

The conference program will consist of plenary lectures (45 minutes each) and session lectures (30 minutes). It will be concerned with recent developments in the following areas of coordination chemistry:

- (1) Synthetic and structural aspects, and bonding theories.
- (2) Ligand reactivity, kinetics and reaction mechanisms.
- (3) Coordination chemistry in biological systems.
- (4) Catalytic and technological aspects.

Detailed **abstracts** of plenary lectures and brief abstracts of session lectures will be published and distributed to delegates at the time of registration.

**English** will be the official language of the conference for all contributions and oral presentations. No translation facilities for other languages will be available.

**Accommodation** will be provided in both western and Indian style hotels of various categories. Advance payment within specified dates is required for reservation of accommodation.

Intending participants are requested to contact the Indian Consulate Office or Mission in their particular country to obtain information about **visas**.

**Further information** about the conference can be obtained from: Professor D. Banerjee, Sir Rashbehary Ghose Professor of Chemistry, Calcutta University, Department of Chemistry, University College of Science, 92 Acharya Prafulla Chandra Road, Calcutta 700 009, India. Telephone: 35-9186.

The conference has been organized by the Indian Chemical Society, and is being sponsored by the Indian National Science Academy, the Dept. of Science and Technology of the Indian Government, and IUPAC.

## ***The Seventh International***

# ***Congress on Catalysis***

***30 June–4 July 1980***

***Tokyo, Japan***

The theme of the congress will be “New Horizons in Catalysis”. It recognizes that the future of mankind will depend largely upon scientific and technological progress in developing catalysts for dealing with pollution, natural resources and energy conservation. Emphasis will be placed upon heterogeneous catalysis. The congress committee encourages the submission of high-level scientific papers dealing with industrial applications of catalysts, as well as the fundamental understanding of heterogeneous catalysts. Examples of topics expected to be discussed are: surface studies with

new instrumental techniques, catalyst preparation (including heterogenization of metal organic complexes), and developments of new catalytic processes of technological importance.

There will be a few invited lectures, but the major portion of the program will consist of contributed papers and communications. These will be selected (if more are submitted than can be accommodated) on the basis of recent and important results.

Prospective **authors of contributed papers** should submit an abstract not exceeding 800 words before 31 July 1979. Authors will be informed whether they should subsequently submit a full paper. Complete manuscripts of papers should be received by 12



January, 1980. **Communications** will be selected on the basis of abstracts of 800 words, received before 12 January, 1980.

The time allotted for contributed papers will be strictly limited, with sufficient time for discussion. More time may be allocated for communications although discussion times will be less.

**Preprints** of plenary lectures and papers, and abstracts of communications, will be provided to participants in advance of the congress.

All invited lectures, contributed papers, communications and discussions should be presented in **English**. The organizing committee is willing to arrange for a suitably qualified person to present papers or communications of authors who foresee language difficulties.

A program of evening **social events** is planned during

the week of the congress. Ladies programs are planned, including excursions and shopping tours. The time of the congress corresponds to the last stage of the rainy season in Tokyo, with average temperatures of 21° and 25°C for June and July respectively.

Lectures, contributed papers and communications will be published in the **Proceedings of the Congress**, which will be available to participants at a reduced rate. Discussion comments on contributed papers will also be published in the Proceedings.

**Further information** can be obtained by contacting: Professor Iwao Yasumori, Seventh Int'l. Congress on Catalysis, Department of Chemistry, Toyko Institute of Technology, Ookayama, Meguro-ku, Tokyo 152, Japan.

The congress is cosponsored by the Chemical Society of Japan, the Catalysis Society of Japan, and IUPAC.

## **5th International Symposium on Solute–Solute–Solvent Interactions**

**2–6 June 1980**

**Florence, Italy**

The program scheduled for the conference includes four plenary lectures on topics of wide interest, and a number of lectures given in two parallel sessions. Poster sessions, microsymbiosia and discussion panels are also planned. Topics that are expected to be covered include: **Thermodynamics of Solution Equilibria**, Kinetics and Reaction Mechanisms, Homogenous Catalysts, Biological Interactions, Theory of short and long range

interactions, Interactions in Coordination Chemistry, Spectroscopic Investigations of Interactions, Electrochemistry, Relaxation Phenomena, Computer-Assisted Methods, and Diffractometric Structural Studies.

The symposium will be held at the Congress Palace in Florence.

**Additional information** can be obtained from Dr. Andrea Dei, Istituto di Chimica Generale della Facoltà di Farmacia, Via G. Capponi 7-50121 Firenze, Italy. Telephone: (055) 296151.

## **10th Int'l. Symposium on Carbohydrate Chemistry**

**7–11 July 1980**

**Sydney, Australia**

All aspects of the chemistry and biochemistry of carbohydrates will be embraced by this symposium, including industrial and medical applications. It will include plenary lectures, short (30 minutes) invited lectures, contributed papers, and poster displays.

Scientific sessions are planned for mornings and some evenings, leaving afternoons free for sightseeing. This timetable is designed to make best use of daylight. Sundown is about 5 p.m. during the July midwinter in Australia. The climate is cool during this time of the year, averaging 16°C maximum and 8°C minimum.

During the week preceding the symposium, two **related meetings** will be held. The Division of Cereal Chemistry of the Royal Australian Chemical Institute will hold a pre-conference workshop of "Cereal Carbohydrates—Industrial and Nutritional Aspects". Further information on the workshop can be obtained from Prof. B. A. Stone, Dept. of Biochemistry at LaTrobe University, Bundoora, Victoria 3083. Also to be held in the week prior to the symposium is a meeting of the "Arabinogalactan-Protein Club", about which enquiries should be addressed to Dr. A. E. Clarke, School of Botany, University of Melbourne, Parkville, Victoria 3052

**Accommodation** for the Carbohydrate Symposium is expected to be provided in modern halls of residence on the campus at the University of New South Wales. Rooms will also be available for a few days before and after the symposium. The cost of such accommodation, including meals, for the period of the symposium is 110 Australian dollars (in November 1978, the exchange rate for one Australian dollar was 1.14 dollars, US). Rooms have also been reserved in several motels within walking distance (10–15 minutes) of the lecture theatres.

The official language of the symposium will be **English**.

All scientific sessions will be held at the University of New South Wales, located 7 km from the centre of Sydney and 6 km from Sydney Airport.

Plenary lectures from the symposium are expected to be published in *Pure & Applied Chemistry*.

**Further information** can be obtained from: The Secretary, Xth International Symposium on Carbohydrate Chemistry, School of Chemistry, The University of New South Wales, Kensington N.S.W. 2033, Australia.

The symposium is sponsored by the Australian Academy of Science (through its National Committee for Chemistry), as well as the IUPAC.



## Notes & Projects

The Commissions on *Terminal Pesticide Residues* and *Residue Analysis* will be merged into one Commission at the Davos General Assembly. Approval is being sought for the name proposed for the new composite group, **The Commission on Pesticide Chemistry**. The new Commission will have 12 titular members and 12 associate members.

Projects of the two Commissions have been integrated and several new ones initiated. A scheme was proposed to provide information to the United Nations Food & Agriculture Organization and the World Health Organization.

It was pointed out that the work of the Commission relates closely to activities of the European Economic Community in regulating pesticide limits. The EEC's first directive on Pesticide Residue Limits came into force in November 1978. Other proposals for regulating or monitoring pesticides (such as in animal feedstuffs) are at various stages of progress. The EEC is establishing methods of sampling and analysis for enforcement of new pesticide limits. They set up a Scientific Committee for Pesticides to give independent advice.

Impurities in crops and other commercial products are also being studied by the Collaborative International Pesticides Analytical Council. They are investigating such impurities as free phenols, nitrosoamines and dioxin. The *Commission on Pesticide Residue Analysis* has been aware of residue problems that could arise from insecticides, and agreed to tackle these problems as they arose.

A summerschool on the **teaching of Medicinal Chemistry** is being advocated by the *Commission on Medicinal Chemistry*. It would be especially set up for representatives of third-world countries and held in Amsterdam during 1980 or 1981. There is a possibility that financial support could be provided by UNESCO (United Nations Educational, Scientific and Cultural Organization). Contacts between the Commission and UNESCO have been developing favorably.

Several new working parties are being formed by the *Commission on Polymer Characterization and Properties*. These groups will begin studies of "Thermal Properties of Polymers", Kinetic Parameters for Free Radical Polymerization", and "Surface Properties". Already, three other working groups have been active within the Commission and have published several technical reports and literature review.

Additional **reprints of published reports** should be supplied to authors so that they could provide copies to editors of appropriate journals, to presidents of IUPAC Divisions, and to members within the author's Division. This was a proposal advanced at the last meeting of the *Commission on Microchemical Techniques & Trace Analysis*. The Commission advocated that authors be supplied with about 50-60 reprints, rather than the 25 copies presently supplied by Pergamon Press. Very lengthy reports were exempted from the proposal.

A **multi-lingual dictionary** of common scientific terms was proposed at the last meeting of the *Commission on Analytical Nomenclature*. The dictionary, to be in English, French, German and possibly Russian, was highly endorsed by the Commission, which planned to undertake the project if it is approved.

A new **Commission on Food Chemistry** will be formed from the merger of the *Commission on Food Properties* and the *Commission on Food Contaminants*. The merger will occur during 1979. It has been suggested that the new Commission should form working groups on Mycotoxins, Metals, and Seafood Biotoxins.

## Technical Studies & Reports

A study on **Reclamation and Re-use of Plastics** was proposed by the *Commission on Reclamation of Solid Wastes*. This Commission points out that disposal of plastics presents special problems, but this area of study is sufficiently limited to be handled by such a small group. Studies by other groups are already in progress on reclaiming solid waste components such as cellulose, metals and glass. It is expected that the study will be published in 1979. Each of its six chapters will be written by one or more members of the Commission.

Proposed Study: Reclamation and Re-Use of Plastics

- (1) Re-use of Polymers
- (2) Separation from non-plastic material
- (3) Use as fuel
- (4) Recovery of useful materials by pyrolysis and Chemical Treatment
- (5) Biological breakdown of plastics in landfill
- (6) Social and economic factors.

The **effects of nickel** on the health of workers is being considered by the *Commission on the Atmospheric Environment* and the *Commission on Toxicology*. Members of the Commission will consider methods of collecting and analyzing particulates and nickel carbonyl in air. The suitability of specific methods can then be reviewed.

Problems have been encountered with calibration methods for **analysis of benzene** at levels lower than one ppm (v/v). The method previously selected by the *Commission on the Atmospheric Environment* (NIOSH charcoal tube method) had problems in areas of high humidity. It was thought that the Exxon Corporation method using a poropak adsorbent might be more satisfactory. The Commission will issue a discussion document on problems of measuring benzene at levels below one ppm, the need for calibration, and the generation of standard atmospheres.



There is a need for a workplace method to collect volatile and non-volatile **N-nitrosamines** in the air, the *Commission on the Atmospheric Environment* concluded at their last meeting, although it was agreed that it was not an environmental problem. A list of publications on N-nitrosamines in air has been compiled, and members have been asked to comment on these.

Methods used to characterize polyethylene and polyvinylacetate samples will be extended to include Infrared Spectroscopy, Carbon-13 NMR, and X-ray and neutron scattering in a report entitled "**Molecular Characterization of Polyethylene**". The study is being prepared by the *Commission on Polymer Characterization and Properties* and is expected to be published shortly in *Pure & Applied Chemistry*. Industrial opinion will be sought on the need for characterization work on synthetic rubbers.

Two technical studies by the *Commission on Polymer Characterization and Properties* have culminated in the preparation of the reports "A Collaborative Study on the **Mechanical Properties of rigid PVC—Effect of Fillers**" (see News Highlight in this issue), and "A Collaborative Study of **Oriented Polymers—Rubber Modified Polystyrene**". Both reports appear this year in *Pure & Applied Chemistry*.

Other reports are in final stages of preparation. These concern the melt rheology of a thermoplastic elastomer of the A-B-A block copolymer type, stress relaxation experiments on SBS block copolymers, and studies of impact strength and its relevance to real mouldings.

A report on the "**Chemical Physics of Surfaces**" is presently being prepared in a collaborative effort between the *Commission on Colloid and Surface Chemistry* and the *Commission of Electrochemistry*.

The *Commission on Microchemical Techniques & Trace Analysis* has undertaken a group of projects. Several reports are complete, or nearly finished. This includes **Stability of Synthetic Standard Solutions** (Part 5 of General Aspects of Trace Analytical Methods). Practical work has been completed on studying 14 trace metal standard solutions with concentrations below 10 µg/l. Concentrations of the standard solutions were monitored with time for different container materials and acid concentrations. A significant contribution to this work was made by the US National Bureau of Standards.

Other technical reports that are expected to be completed soon are: Methods of **Multielement Pre-concentration from Pure Lead** by Precipitation of the Matrix, Applicability of **Pressurized Sample Dissolution** in Trace Analysis of Biological Materials, and **Preconcentration for Inorganic Trace Analysis**. A project on the **Analysis of Organoboron compounds** has already been completed and accepted as an internal report of the Commission. The report may be published as a personal (non-IUPAC) paper in a journal.

A proposal has been approved to study **Analytical Methods for Determination of Trace Elements in Biological Materials**. The lack of existing methods to determine trace components in biological materials was pointed out to the Commission. The report should include all types of biological materials and deal extensively with sampling and homogeneity.

"Proposed Guidelines for Testing Single Cell Protein Destined as **Protein Source for Animal Feed**" has been prepared in draft form by the *Commission on Food Contaminants* working with members of the

*Commission on Fermentation*. The draft includes an evaluation of the nutrition and toxicology of Single Cell Protein (SCP), and specific standards for the product. It also includes a discussion of methanol production processes, methanol-utilizing micro-organisms, SCP production processes based on methanol, and typical analysis of pilot-plant samples (bacteria and yeast) made from methanol. It was noted at the Commission meeting that over one quarter million animals have been fed SCP as part of their diet. The Commission on Food Contaminants will publish the report, subject to the agreement of the Fermentation Commission.

**Contaminants derived from food packaging** is the subject of two studies. One study concerned vinyl chloride and vinylidene chloride in packaging materials, edible fats and dairy products. From the results obtained, it was evident that vinyl chloride concentrations of less than 1 mg/kg of packaging material was technically feasible. Contamination of food by vinyl chloride has so improved that the subject was deemed to be of low priority. A summary report on vinyl chloride in packaging materials is to be published. The Commission is now undertaking a study of the migration of acrylonitrile from packaging materials.

Progress has been reported in the study of chemical procedures for the analysis of saxitoxin, a **toxin found in seafood**. The aim is to obtain a chemical method that would be an acceptable substitute for the biological assay now used. However, there are considerable difficulties to be overcome. The toxin that is responsible for paralytic shellfish poisoning can contain many components, of which saxitoxin sometimes is only a minor part. Since a saxitoxin standard is the only reference now available, results of a chemical test might be incompatible with a bioassay. Furthermore, there is difficulty transporting frozen samples since the toxin could decompose. The canning of samples has been recommended. It is hoped that this complex situation will be clarified in upcoming months, and a plan formulated for collaborative study. It was also reported that the UN World Health Organization has asked the project leader of the *Commission on Food Contaminants* to produce an Environmental Health Criteria Document on Marine Biotoxins.

A method for the determination of copper in foodstuffs has been finalized and published early this year (see News Highlights this issue). Now, a method was being prepared for determining lead and cadmium in food. The method includes dry ashing and wet oxidation, followed by selective extraction and preconcentration for atomic absorption analysis. Another method for determining mercury in food has also been reviewed and is being prepared for publication. The *Commission on Food Contaminants* also recognized that the monitoring of fluoride in food is of considerable interest, and they may consider publication of an accepted method.

## Publications

The *Commission on the Atmospheric Environment* plans to prepare a report "**An Approach to the Estimation of Air Contaminants**". It would be a guide for people in small industries and developing countries. A previous report about sampling air in the working environment, general environment and stacks would serve as a starting point.



Four reviews on insecticides were published last year by the *Commission on Terminal Pesticide Residues*. These deal with organochlorine, organophosphorus and carbamate insecticides, ethylene oxide and methyl bromide fumigants. The special projects reports on toxaphene, chlorophenols and nitrosopesticides were presented to the Commission and approved in principle. Final copies will be submitted to the Applied Chemistry Division for approval to publish.

A paper "**Characterization and Determination of Pesticide Residues**" will be produced by the *Commission on Pesticide Residue Analysis* (soon to be merged). It will combine the contents of three previously-published reports.

"**The Evaluation of Pesticide Residues in Food: Procedures and Problems in Setting Maximum Residue Limits**" has been circulated for information and is to be published in the *Journal of the Science of Food and Agriculture*. It summarizes some problems encountered in evaluating residue data.

Good progress has been reported by the working party on supported polymer films (*Commission on Polymer Characterization and Properties*) on "**Analysis of Functional Groups in Amino Resins**". A literature survey of the subject has been published in May 1978 in the *Journal Progress in Organic Coatings*.

A project on "**Adhesion**" has also continued, and a survey of adhesion testing has been submitted for publication in the *Journal of the Colour Chemists Association*.

The *Commission of Electrochemistry* reports that the main software part of the "**Conductance Data Compilation**" system is working. The amount of information being processed and stored is steadily increasing. However, before this information is freely accessible to the scientific community, a way to display the information must be determined.

Another project to compile data is reported by the Electrochemistry Commission. A "**Critical Compilation of Electrode Potentials**" is being prepared in collaboration with the *Commission on Electroanalytical Chemistry*. A working group has been established for this project.

A publication on **Radiation Sources** was the main topic of discussion at the last meeting of the *Working Group on Radiation Sources* (Commission on Spectrochemical and other Optical Procedures for Analysis). Most of the sections had already been contributed by members, and the style, policy and detail were compared and coordinated. It was proposed that another chapter follow the introduction to discuss concepts common to all light sources. This chapter would include common definitions (plasmas, pressure, thermal and non-thermal equilibrium), terms pertaining to sample preparation, and the types of radiation (atomic, molecular, continuous, etc.). The section on low-pressure gaseous discharges will be changed to incorporate definitions given in the early chapters. It was also decided to separate Radio frequency and Microwave sources into two chapters.

A joint publication covering all methods for **determination of mycotoxins** is being considered by the *Commission on Food Contaminants* in conjunction with the UN Food & Agriculture Organization, World Health Organization and Association of Official Analytical Chemists. Plans are being considered to use the publication in connection with workshops or training courses sponsored by the Food & Agriculture Organization.

A highly successful monograph on **Education in Clinical Chemistry** at the international level is expected

to be updated by the *Commission on Teaching in Clinical Chemistry*. It was suggested at the Commission's last meeting that the monograph should include programs of new member nations, and changes in programs of current members. The monograph is expected to be updated during the period 1981-1982.

A prospectus and suggested syllabus for **MSc-level training programs** for clinical chemistry specialists was widely accepted by the national representatives of 28 countries. A draft of the proposed prospectus/syllabus had been submitted for comment to 39 countries by the *Commission on Teaching in Clinical Chemistry*. It is now being revised to include a preamble on the role envisaged for the MSc graduate, and the syllabus is being abbreviated, the document will be prepared for publication in early 1979.

Education programs for **clinical chemistry technologists** should be designed so that qualified technologists can enter courses leading to higher degrees. That is a main emphasis of a document prepared by the Commission on Teaching & Clinical Chemistry. The initial draft of the document has been condensed, and will be subject to critical comment.

The **Nomenclature of Inorganic Chemistry**, published as the well-known "Red Book", will be revised. The *Inorganic Nomenclature Commission* decided to rewrite the book completely. A strategy for re-organization of the book was accepted at the Commission's last meeting. An evaluation of the book had indicated several obvious deficiencies. It was felt that many closely-related names for inorganic compounds could be derived by different individuals. In particular, the present edition of the "Red Book" gives little guidance on naming organic ligands, on multiplicative prefixes and punctuation.

## Nomenclature

A report on the **definition of terminal residues** has been approved for publication by the *Commission on Terminal Pesticide Residues* (to be merged, see Special Notes). It has been submitted to the IUPAC editorial board for approval.

At the last meeting of the *Macromolecular Nomenclature Commission*, substantial decisions were taken on two nomenclature documents: "**Stereochemical Definitions and Notation Relating to Polymers**", and a revised version of a document on **copolymer nomenclature**. The Commission considered basic terms relating to polymer physics and agreed to restrict their initial efforts to those terms peculiar to polymer science, and to update terms defined in a 1952 document. Working parties will be organized to consider Solids and Concentrated Solutions, Dilute Solutions, the Crystalline State, and the Amorphous State. The Commission is also preparing a document on the **nomenclature of macrocyclic compounds** (such as crown ethers). This would be based upon the Commissions previously-adopted rules for Structure-Based Polymer Nomenclature.



Corrections and amendments have been incorporated into the provisional nomenclature recommendations on **Transport Phenomena in Electrolytic Systems**, and **Electrode Reaction orders, Transfer Coefficients and Rate Constants**. The *Commission of Electrochemistry* plans to proceed towards publishing these recommendations in definitive form.

The Electrochemistry Commission is now considering a document on "Recommendations regarding the **Selection of Reference Redox Systems**."

A provisional nomenclature report on **Analysis of Solid Surfaces** (Part 4 of "General Aspects of Trace Analytical Methods") has been prepared by the *Commission on Microchemical Techniques & Trace Analysis*. The report is being reviewed by the Analytical Nomenclature Commission and the Interdisciplinary Committee on Nomenclature & Symbols. Two other nomenclature reports in the series, **Standard Reference Materials for Trace Analysis** and **Contamination in Trace Analysis**, were published in late 1978 in *Pure & Applied Chemistry*.

## Conference Sponsorship

Discussions are in progress to arrange finance for a symposium on **Analytical Aspects of Ozone**. It would discuss substances which enhance or reduce levels of

ozone in the Stratosphere or Troposphere. The *Commission on the Atmospheric Environment* is discussing funding with the United Nations Environmental Programme. If the funds can be obtained, the symposium would be held in late 1979 or early 1980.

The 5th IUPAC **Congress on Pesticide Chemistry** will be held in 1982 in Japan, the *Commission on Pesticide Residue Analysis* announced. The exact site and date have not yet been finalized. The Congress is expected to have the same general framework as the previous Zurich meeting, but additional symposia before and after the main Congress are being considered.

The *Commission on Medicinal Chemistry* is considering the following symposia for IUPAC sponsorship:

- (1) 7th International **Symposium on Medicinal Chemistry** to be held in Spain, 2-5 September, 1980. A subsequent symposium on the same subject is also being planned for 1984 in Sweden. Following that, a 9th International Symposium on Medicinal Chemistry is expected to be held in the Federal Republic of Germany in 1986.
- (2) "**Medicinal Chemistry Symposium of the America's**" Organized by the American Chemical Society and Chemical Institute of Canada, to be held in Toronto (Canada), 21-24 June, 1982.
- (3) A **Symposium on Biological Activity and Chemical Structure**, to be sponsored by IUPAC and the International Union of Pharmacology and held in the Netherlands in 1981. It should be similar to the previous conference held on the same topic in 1977.

## OFF THE PRESS

Recent IUPAC publications

### World Food Production—Environment—Pesticides

H. Geissbuhler, P. C. Kearney and G. T. Brooks — editors, 66 pages (March 1979)

This book considers strategies of world food production, the future of crop protection, safe use of pesticides, toxicology, regulation of pesticides, and the aims of pesticide research. It is based upon lectures presented by five invited speakers at the 4th International Congress of Pesticide Chemistry, held in

Zurich, Switzerland in July 1978. The information is most likely to be of interest to pesticide and agricultural scientists, regulatory agencies, and those concerned with insecticides and growth regulators. It is available in flexicover edition (£10, or 20 US dollars), and hardcover edition (£5, or 10 US dollars).

### Manual of Symbols and Terminology for Physiochemical Quantities and Units

IUPAC Division of Physical Chemistry; Commission on Symbols, Terminology & Units, 37 pages (1979 edition)

This basic bible of symbols and terminology, often referred to affectionately as "the Green Book", is similar to the earlier 1973 edition. Minor corrections have been incorporated following rulings within IUPAC and other international bodies. The manual, including Appendix I, have been published in *Pure & Applied Chemistry*, No. 1 (1979) or is available as a bound softcover edition (cost: 7.50 US dollars).

Appendix II (Terminology for Colloids and Surface Chemistry) was published separately in two parts, both in *Pure & Applied Chemistry* [Vol. 31 (1972), p. 577 and 46 (1976) p. 71]. Appendix III (Electrochemical Nomenclature) is to be found in *Pure & Applied Chemistry*, 37 (1974), p. 499. Finally, Appendix IV has been published this year in *PAC*, No. 2.

## **The Role of Laboratory Teaching in University Chemistry Courses**

By A. R. H. Cole *et al.*, 68 pages (February 1979)

The need for formal instruction for graduates intending to become laboratory instructors is a main subject of this set of eight lectures. The other major focus is the problems of teaching laboratory chemistry courses, especially in developing countries. Some of

the topics discussed are: Are laboratory courses necessary? Integrating laboratory with lectures, Development of chemistry laboratories in developing countries, and Chemistry laboratory courses in the US and USSR. Each chapter is based upon the presentation of an invited speaker at an international conference dealing with Chemistry Laboratory Teaching, held in Perth, Australia in February 1978. The lectures are bound in a hardcover edition, and cost £5 or 10 US dollars.

## **Combustion Calorimetry Volume 1, Experimental Chemical Thermodynamics**

Stig Sunner and Margaret Mansson – editors, 462 pages (April 1979) Flexicover edition costs £12 (25 US dollars); Hardcover volume is £25 (50 US dollars).

## **Ionization Constants of Organic Acids in Aqueous Solution**

E. P. Serjeant and B. Dempsey – editors, 998 pages (February 1979). This volume contains ionization constants of 4500 acids. It is compiled from data presented in the chemical literature between 1956 to the end of 1970. This hardcover reference work costs £62 (125 US dollars).

## **Future Sources of Organic Raw Materials**

L. E. St Pierre – editor, 500 pages (1st quarter 1979). Lectures presented at the World Conference on Future Sources of Organic Raw Materials (CHEMRAWN), held in Toronto, Canada in July 1978. Price of the hardcover edition is £22.50 (45 US dollars).

## **Volume 6: Nitrogen Int'l. Thermodynamic Tables of the Fluid State**

S. Angus, K. M. de Reuck and B. Armstrong – editors, 276 pages (May 1979). A compilation of internationally agreed values of the equilibrium thermodynamic properties of nitrogen. Available in hardcover edition. Cost is approx. £30 (60 US dollars).

## **Advances in Pesticide Science**

H. Geissbuhler, P. C. Kearney and G. T. Brooks – editors, 850 pages (March, 1979). This three-volume set contains the proceedings of the 4th International Congress of Pesticide Chemistry, held in Zurich, Switzerland in July 1978. Available as a hardcover edition for £75 (150 US dollars).

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The **INFORMATION BULLETIN**  
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# **INTERNATIONAL UNION OF PURE and APPLIED CHEMISTRY**

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The International Union of Pure and Applied Chemistry (IUPAC), formed in 1919, is a voluntary, nongovernmental, nonprofit association of organizations, each of which represents the chemists of a member country.

Its objectives are:

- to promote continuing cooperation among the chemists of the member countries;
- to study topics of international importance to pure and applied chemistry which need regulation, standardization, or codification;
- to cooperate with other international organizations which deal with topics of a chemical nature;
- to contribute to the advancement of pure and applied chemistry in all its aspects.

The membership of IUPAC presently comprises 42 countries, each represented by a national organization, such as an academy of science or research council.

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**International Union of Pure  
and Applied Chemistry (IUPAC)**

# **Information Bulletin**

**A news magazine about  
developments in Chemistry involving  
subjects of International importance**

**1979, No. 2**



**Pergamon**

# Information Bulletin

## NEWS MAGAZINE OF THE INTERNATIONAL UNION OF PURE & APPLIED CHEMISTRY

EDITOR: Dr. Martin Gellender

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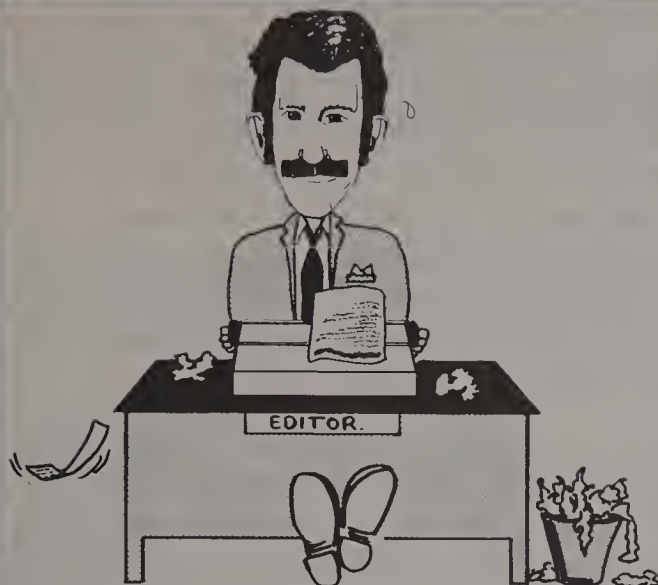
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## THE EDITOR'S DESK

### Will IUPAC score, or lose the ball?

*Those of you that have watched a basketball game at a sports stadium or on television may have noticed one team member remaining in one place, playing the "pivot point". The pivot man receives the ball from his team mates, and waits until one is in an opportune position. At the instant when a team mate is a step ahead of his opponent and heading toward the goal, the pivot man passes the ball.*

*I find myself playing the pivot point much of the time, especially in this column. What I have to toss out may not be original—in this case, it has been repeatedly bounced around the court. But the right instant has come, and IUPAC is in the right position to score a major win. If IUPAC doesn't take advantage of its unique position, the situation will change soon, and the opportunity may be lost forever.*

*The goal, towards which we have already been moving, is an international chemical society. Many of the functions of such an organization are already being performed by IUPAC. Others aren't. Objectives and activities of such a society have been considered in a preliminary proposal prepared by Minoru Tsutsiu (Texas A&M University) and Jesse Hwa (Stauffer Chemical Company) in July 1977. Their informal report noted the following:*

**"Chemistry around the world is supported by a number of organizations, with IUPAC being the central correlating body. It is therefore appropriate to ask, What needs in world chemistry remain unfulfilled by the present organizations?"**

**"The existing organizational structure of world chemistry . . . does not provide a route for direct communications among individual working chemists. Many effective and thoroughly competent chemists in developed nations do not know of IUPAC in any direct way, and they feel a rather strong need for more ready access to their colleagues in other countries."**

**(An international chemical society needs to be) "a very strong and dynamic central organization which could tie efforts of divisions together for larger projects such as . . . development of broad-based symposia and creation of international assistance projects. . . . The motto of such a society could well be taken from the most recent IUPAC project, Chemical Research Applied to World Needs."**

**"Individual membership and control by elected officers seem to be two ingredients which promote direct member interactions and responsiveness to member interest."**

*The report continues, stating the benefits of expanding IUPAC's role into that of an international chemical society. These include a strengthening of IUPAC's financial position with the addition of revenue derived from individual membership dues. Individual membership seems to be the most important element of an international chemical society, and something which IUPAC can readily offer. But individual members cannot simply be regarded as another source of revenue. Activities of IUPAC must be open to them. They should be able to participate in, and become members of IUPAC Commissions. They should be given a vote in the election of officers—now done entirely by Science Academies and other national organizations.*

*The proposal report was submitted two years ago, after an international chemical society was first proposed by Glenn Seaborg, former president of the American Chemical Society. What has changed to make it important for IUPAC to act now?*

*Firstly, IUPAC has already moved even closer to performing the role of an international chemical society than it ever did before. The first CHEMRAWN (CHEMical Research Applied to World Needs) conference was held. It was clearly a success, and further CHEMRAWN conferences are planned. Some IUPAC Commissions have already established informal links with such organizations as UNESCO and WHO to discuss application of modern chemical technology to help people in developing countries.*

*The IUPAC Information Bulletin, the magazine you are now reading, has already been changed to a news medium intended to be readable by chemists throughout the world, including those presently not involved in IUPAC activities. It is now well-suited to serve the needs of individual IUPAC members, should they arise. Indeed, publication of an international news magazine for chemists, provided to all members, is one of the central functions recommended for the international chemical society by authors of the proposal report. They note:*

*"There is a real need today for the creation of a journal which reports general ideas and developments in ongoing research in a short easily-read form . . . a journal deliberately edited to present important general interest research reports from around the world in a brief and available form. (It) would be a service to chemistry of major proportions."*

*Finally, it appears that there is a real need for an international chemical society. A Subcommittee on the Formation of an International Chemical Society has been formed within the International Activities Committee of the American Chemical Society, with Dr. Stanley Kirschner as chairman. Formation of such a society was the subject of a two-hour open forum at the joint meeting of the American and Japanese Chemical Societies, held this April in Honolulu.*

*If IUPAC continues to abstain from forming an international chemical society, other organizations are likely to take the initiative. Should they form an international chemical society, it would most likely compete directly with IUPAC. It would perform many of the functions that IUPAC is already doing, or that IUPAC could easily undertake.*

*On the eve of the 1979 General Assembly, IUPAC is a clear step ahead of all chemistry organizations on the field. But if we don't take advantage of opportunities that are open to us now, they may slip away forever. The ball is in our hands.*

*Martin Zeldner*



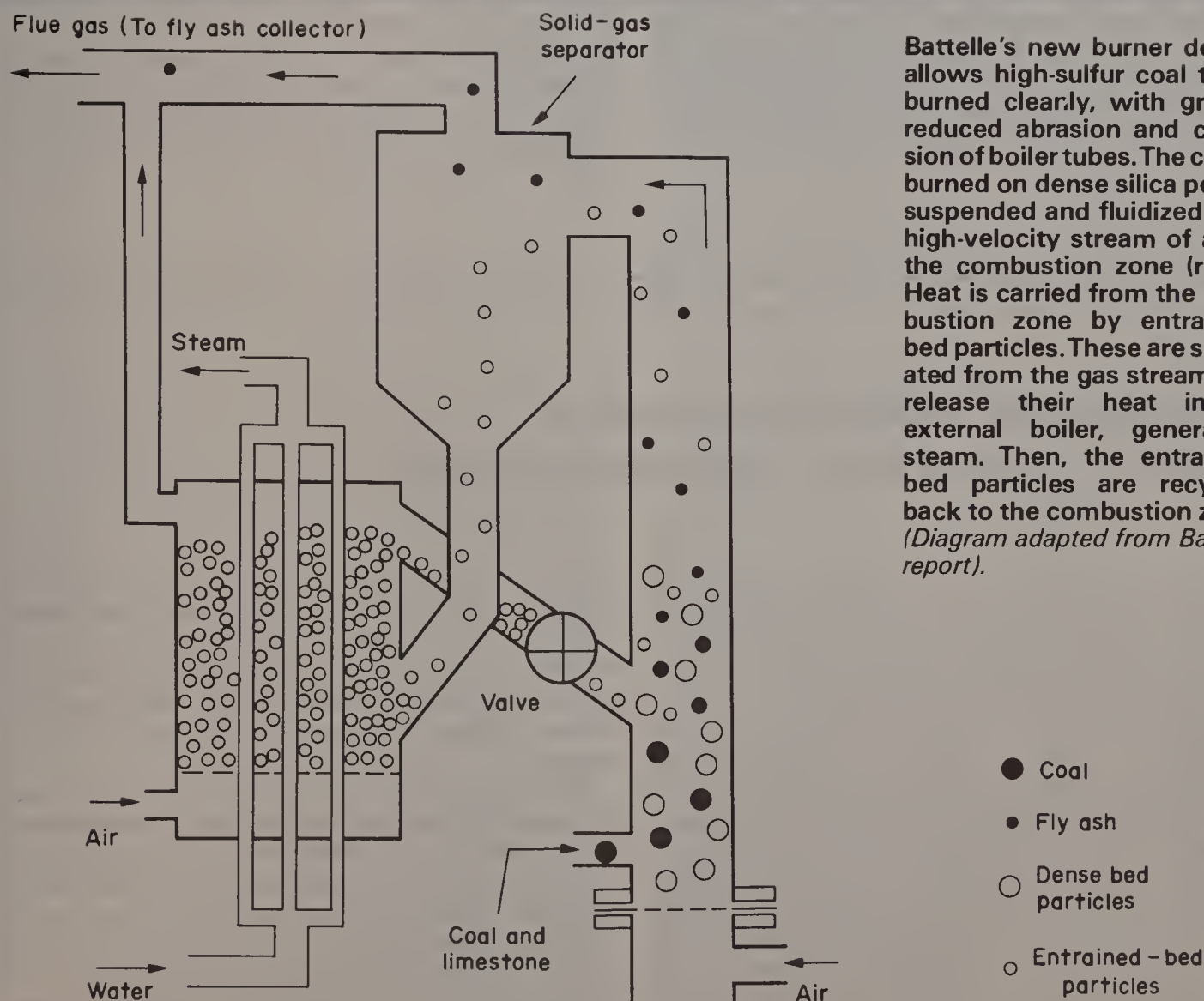
## Conversion of industry to coal looms as sulfur-removal technology matures

A switch from petroleum to coal as primary fuel for industrial and home heating will come about in many countries with massive coal deposits. But in comparison to oil, coal is a dirty, difficult-to-handle fuel. Many coals contain 5% or more sulfur, forming toxic sulfur dioxide when burned. So, will the return to coal as the primary industrial fuel be accompanied by a reversal of recent advances in pollution control, and regression to acrid sooty atmospheres which characterized nineteenth century factories? If not, how are industry and government to reconcile conversion to non-petroleum fuels with stringent environmental restrictions on pollution emissions?

The answers lie in new technology presently being developed for cleaning coal, absorbing sulfur dioxide during combustion, and removing sulfur dioxide from stack gases. As developers of these technologies scramble to make their systems viable and competitive, industry remains poised to see which system – or systems – are most efficient and

economic. The choice will be crucial. The market for high-technology sulfur-removal equipment could eventually reach US \$30 billion in the US, Germany, Japan and Canada alone.

Already, it is clear which alternative technologies will compete for dominance in the research and development race. Some, such as mechanical and chemical treatment of coal to remove sulfur, will be well-suited for a few types of coal. Stack gas scrubbers appear to be the best near-term solution, although these systems form an objectionable waste sludge. No good disposal method has yet been found, and the sludge might become almost as environmentally damaging as the sulfur dioxide which it has entrapped. Allied Chemical's *Sulfur Reduction Process* reduces sulfur dioxide in stack gases to liquid elemental sulfur, a useful byproduct, and has proven itself at a Canadian nickel smelter and at a coal-fired electric generating station in the US. Allied's system recovers more than 90% of sulfur dioxide in



Battelle's new burner design allows high-sulfur coal to be burned clearly, with greatly reduced abrasion and corrosion of boiler tubes. The coal is burned on dense silica pellets suspended and fluidized by a high-velocity stream of air in the combustion zone (right). Heat is carried from the combustion zone by entrained-bed particles. These are separated from the gas stream and release their heat in an external boiler, generating steam. Then, the entrained-bed particles are recycled back to the combustion zone. (Diagram adapted from Battelle report).



the effluent gases, but relies on increasingly valuable natural gas as a chemical reductant. Allied will need to utilize other hydrocarbon reductants in their process if it is to vie with contenders like Foster Wheeler's *Resox Process*, which reduces sulfur dioxide to elemental sulfur with anthracite coal. Anthracite is also a high-grade fuel that is not found in many areas, but the process will likely be modified to utilize other carbon reductants.

The most direct means of sulfur removal is within a fluidized-bed burner. Here, coal is burned upon granular particles suspended (fluidized) by a high-velocity stream of air. The bubbling action of the solid particles causes rapid mixing, heat transfer and contact between fluidized particles and gas. One component of the fluidized bed is granules of limestone or dolomite (calcium or magnesium carbonates). This reacts with sulfur oxides formed during combustion, forming calcium sulfate. Typically, 90% of sulfur dioxide is removed from combustion gases. Several prototype burners are already in service burning high-sulfur coal, pulpmill effluent, wood waste and garbage. Experience so far indicates that fluidized-bed burners will be well-suited to new industrial and utility boilers, as well as for retrofitting existing oil and coal-fired boilers.

A recent technological development now appears likely to solve the few remaining problems barring widespread use of fluidized-bed burners. Erosion and corrosion of boiler tubes within an experimental fluidized-bed boiler led researchers at Battelle Research Laboratories to develop a burner with an external boiler. They discovered that this configuration circumvented abrasion of steam tubes by impacting bed particles and corrosion by combustion gases: two problems encountered in conventional designs with steam tubes incorporated in the combustion vessel.

Battelle's Multi-solid Fluidized-Bed Combustor utilizes a fluidized bed with two types of particles. The first consists of granules of dense silica pebbles, which is fluidized in the combustion zone by a stream of air at high velocity (10–15 metres/second). Crushed coal is ignited and burns on the hot silica pebbles, while sulfur dioxide is absorbed by limestone particles within the bed. A second layer of lighter particles above the combustion zone absorbs heat from the 900°C combustion gases and is carried upward by the gas stream – through a gas-solid separator, and into an external boiler. This “entrained” bed material releases its heat to steam tubes in the external boiler, and is then recycled back to the combustion zone. The external boiler consists of steam tubes within a conventional fluidized-bed operated so as to obtain maximum heat transfer from bed particles to tubes.

The Multi-Solid Fluidized-Bed Combustor with external boiler has, so far, been tested only with a bench-scale unit (15 cm diameter, and 7 metres high) consuming 20 kg coal per hour. Based upon their experience with this unit and a larger combustor with integral boiler, Battelle is now planning to build a demonstration fluidized-bed burner with the capacity to burn 2000 kg/hour of coal. The project is described in a *Special Report on the Status of Battelle's Multi-Solid Fluidized-Bed Combustion Process*, December 1978 (available from A. B. Westerman, Project Management Office, Battelle Columbus Laboratories, 505 King Avenue, Columbus, Ohio 43201, USA). If funding is provided as expected, construction of the plant could start in mid-1979. The demonstration fluidized-bed boiler could begin operation by the middle of next year, providing the first operating data that may establish or disqualify it as the leading contender for the powerplant of the future.

## An endemic laboratory hazard—mercury poisoning—can be avoided

The use of mercury in laboratory equipment subjects chemists to the potential hazard of chronic poisoning, especially from inhalation of mercury vapour. Many scientists have been severely afflicted by mercury poisoning. One of its earliest victims was Sir Isaac Newton. It is now reasonably certain from reconstruction of Newton's laboratory and analysis of his tremulous handwriting that exposure to mercury caused mental deterioration of this brilliant scientist at age 50. Other eminent scientists, including Pascal and Faraday, are now believed to have suffered mercury poisoning. During the last two centuries, industrial accidents and spillages of mercury salts are estimated to have caused 650 deaths, with another 1000 people

seriously affected. These figures do not include countless thousands of chemists, industrial workers or exposed populations who have suffered a mild form of poisoning. Reliance upon mercury as a manometer fluid, in polarography, and as a chemical reagent is decreasing, but is still prevalent.

What can be done by chemists to minimize the hazard of mercury in their own laboratories? Several very effective measures are available, and are discussed in an article in the December 1978 issue of *CHEMSA*, the journal of the South African Institution of Chemical Engineers. The article, *Hazards of Mercury in special reference to Elemental Mercury in the Laboratory*, points out that spilled droplets of mercury metal will soon



generate toxic levels of mercury vapour in poorly ventilated laboratories. Confined to an enclosed room at a temperature of 20°C, mercury will evaporate until reaching its equilibrium vapour pressure of 13.2 mg/m<sup>3</sup>. This is 265 times the 0.05 mg/m<sup>3</sup> limit (termed the "Threshold Lower Value) established for occupational exposure by an international committee. Mercury vapour is readily absorbed by the body through the lungs, a curious contrast to the inertness and apparent lack of toxicity when liquid mercury is swallowed.

Will the concentration of mercury vapour under real laboratory conditions approach its equilibrium vapour pressure, or will it be dispersed by air currents far more rapidly than it can evaporate? The author of the *CHEMSA* article, Dr. T. M. Letcher, measured mercury levels in his own laboratory at the University of Witwatersrand. He found mercury levels as high as 0.3 mg/m<sup>3</sup> in a room with open doors but without cross-ventilation. In closed cupboards and boxes, levels of mercury approached the equilibrium vapour pressure. The likely source of contamination was invisible droplets that had collected in floor cracks.

Even greater danger arises when mercury is heated. The equilibrium vapour pressure at 100°C is about 50 000 times the Threshold Lower Value (TLV) for occupational exposure. Only a few minutes would be required for mercury vapour concentration to exceed the TLV when a small amount of mercury is heated in a closed unventilated room. These very conditions are often present in laboratories, dental surgeries, and factories in countries with cold climates, where windows and doors may be closed while the ventilation system is turned off.

The hazard of spilled mercury can be greatly reduced by thorough clean-up of mercury droplets, applying measures that inhibit evaporation of mercury, and detecting mercury vapour in the laboratory.

Mercury droplets are notoriously difficult to clean up. Perhaps the most common method is to suction the droplets through a pipette into a reservoir connected to a vacuum pump. A novel clean-up method discussed in the article is freezing droplets with liquid nitrogen or carbon dioxide/acetone mixture, and then scooping the frozen droplets onto a piece of paper. Recovered mercury should always be kept in a sealed bottle, or under a layer of water. Once larger drops have been recovered, sulfur can be sprinkled on the area, converting remaining droplets to nonvolatile mercuric sulfide.

Covering liquid mercury with a layer of water has long been used to reduce evaporation. The effectiveness of this method has recently become subject to question. Some chemists have argued that a covering layer of water will not reduce the equilibrium vapour pressure of mercury in the air above it, basing their argument upon well-known thermodynamics theory. But will a layer of water (or other liquid) *slow* evaporation of mercury?

Dr. Letcher's measurements show that the answer is definitely yes. Diffusion of mercury through a layer of water is apparently one-thousand times slower than escape of mercury directly by diffusion into the air. Mercury vapour evaporating from a water-covered pool of mercury would be insignificant, even in poorly-ventilated laboratories. Viscous liquids are even more effective than water. Dr. Letcher found that glycerol behaves as an almost impregnable barrier to mercury evaporation.

A simple chemical detector can be fashioned to monitor mercury vapour levels in laboratories. The method utilizes the color change of a paper disc impregnated with palladium chloride (1% solution) when it is exposed to mercury vapour. The reaction which apparently causes this colour change is:



The original yellow-brown colour of the disc darkens to grey when mercury vapour impinges upon it. The colour of the exposed disc is compared against a set of standard grey discs to determine to dosage (time of exposure  $\times$  concentration of mercury in the air). This simple method can determine mercury concentrations with an estimated sensitivity of 1  $\mu\text{g}/\text{m}^3$ .

A more sophisticated and convenient method is presently being developed which utilizes a small reusable dosimeter badge which can be carried by laboratory or plant workers. The main component is a piezoelectric crystal contained in a glass holder through which air is drawn by a miniature air pump. A gold coating on the crystal selectively absorbs mercury vapor. Adsorption of tiny amount of mercury (as little as a picogram) changes the characteristic frequency at which the crystal vibrates when an electronic signal is applied. The frequency shift indicates the cumulative amount of mercury to which the wearer has been exposed during a selected time period. Greatest sensitivity during short exposure is provided by piezoelectric crystals with a high frequency of oscillation (15 MHz), but these have less adsorption capacity than lower frequency crystals. After sampling and frequency measurement, mercury is desorbed from the crystal by passing hot clean air over the sensor in an oven. The developer of the technique, Dr. Eugene Scheide, notes (in Technical Report 963 of the US National Bureau of Standards) that it may be feasible to use piezoelectric crystals as sensitive and selective sensors for other toxic vapors as well as mercury.

In undergraduate teaching laboratories, complex monitoring systems are not likely to be used and it is especially important to anticipate mercury spillages when selecting and conducting experiments. Potentially dangerous demonstrations (such as the reversible dissociation of mercuric oxide, generating oxygen) should be confined to fume hoods with good extraction fans. Perhaps the best precaution is not to use mercury at all unless no alternative experiments of materials may be substituted.



# Zeolite catalysts with new properties offer improved reaction yields

The versatility of zeolite catalysts and sorbents has grown steadily ever since their outstanding properties were recognized in the 1940's. Commercial applications soon followed the discovery that zeolites could discriminate between compounds with very similar structure. Zeolites can selectively absorb water, ammonia, sulfur dioxide or carbon dioxide from contaminated gas streams. Others separate straight-chain (normal) hydrocarbons from branched hydrocarbons in a single pass through the material. Some catalyze the cracking of hydrocarbon molecules, with far greater activity than conventional silica-alumina catalysts. Even more significant, zeolite catalysts have the ability to act selectively upon one component of a mixture. Straight-chain hydrocarbons can be cracked to smaller molecules, while branched-chain hydrocarbons are excluded from reaching active catalyst sites because their size and shape prevents diffusion through channels in the zeolite structure.

Useable zeolite crystals are often found in cracks and cavities in basaltic rocks, but these occur too sporadically to be commercially useful. The lack of known deposits of sufficient size created the initial impetus for chemists to synthesize naturally-occurring zeolites. In 1948, the first zeolite with no natural counterpart was made. It soon became apparent that synthetic zeolites could have properties not found in the 35 or so naturally-occurring zeolites, and subsequent discoveries of massive sedimentary deposits of natural zeolites did little to deter further development of synthetic zeolites.

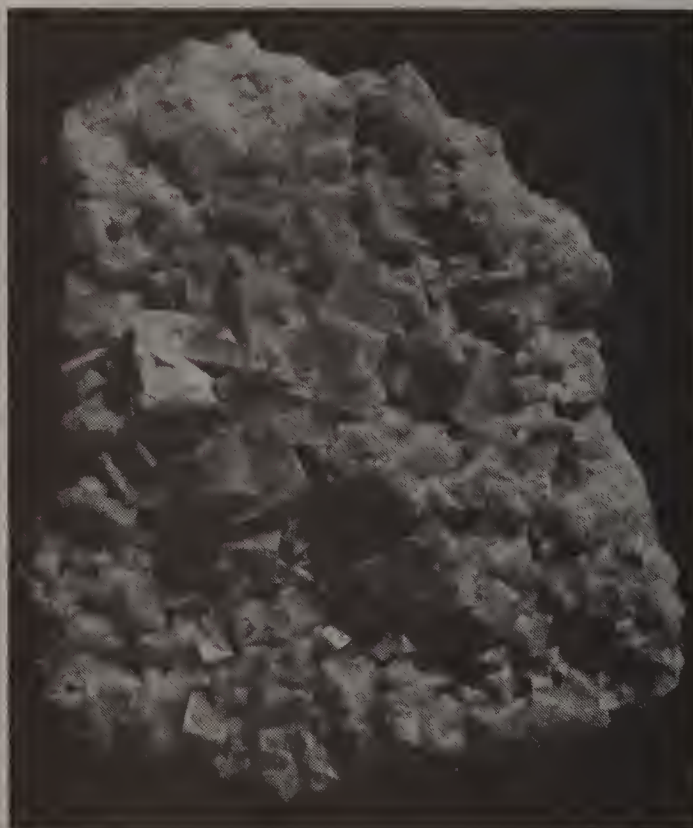
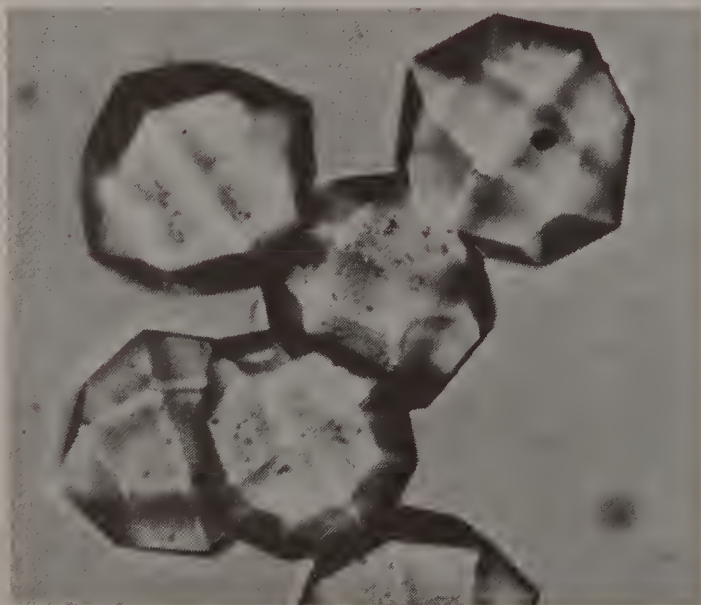
In the last 15 years, zeolites have proliferated as industrial and laboratory sorbents, ion exchange

materials, and catalysts. Most of the straight-chain hydrocarbons obtained commercially (1.6 million tons used globally in the manufacture of biodegradable detergents, plasticizers, and single-cell protein) are separated from other hydrocarbons by zeolite sorbents. Zeolite "molecular sieves" are the only effective means available to recover straight-chain olefins from hydrocarbon mixtures. For separating oxygen from air (up to 25 tons/day), the selective sorption of nitrogen by zeolites is an economic method.

Zeolite catalysts for cracking heavy hydrocarbons into gasoline were first introduced in 1962 by the Mobil Oil Company. They have now displaced alumina-silica catalysts in nearly all US petroleum refineries, and in many other refineries throughout the world. Only very recently, Mobil developed a process utilizing a zeolite catalyst to convert methyl alcohol directly into synthetic gasoline. That process could become a pivotal step in the development of a multi-billion dollar international industry to make liquid hydrocarbons from coal.

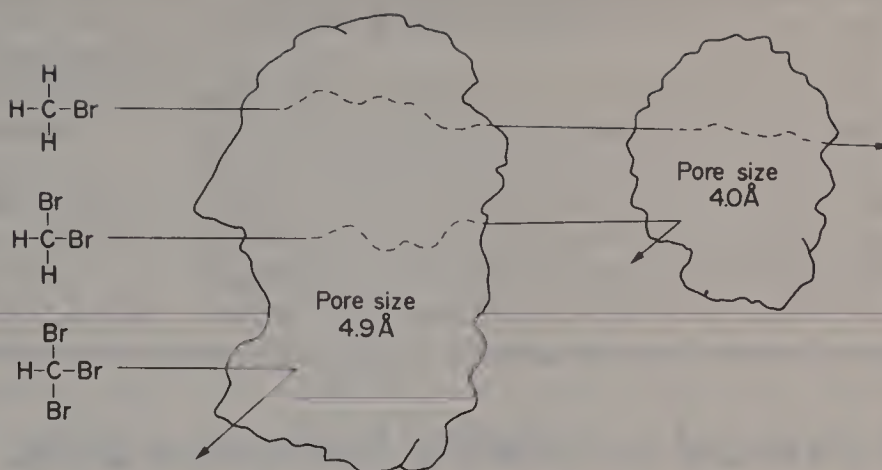
The unique properties of zeolites are due primarily to their open crystalline structure. The chemical compositions of zeolites are similar to those of other tectosilicate minerals, such as feldspars and feldspathoids, but only zeolites have an open structure which allows molecules and metal ions to move freely within the crystalline framework. The porous three-dimensional structures of zeolites result from linking together tetrahedra of  $\text{SiO}_4$  and  $\text{AlO}_4$ . Synthetic zeolites have the same type of structure, except that some or all the aluminum or silicon in the framework may be replaced by gallium or germanium. Silicon and

Two zeolites: A cluster of natural chabazite crystals (right), and synthetic analcite crystals magnified 500× (below). Analcite has the composition  $\text{Na}[\text{AlSi}_2\text{O}_6]\text{H}_2\text{O}$ . (Photos courtesy of Prof. R. M. Barrer, Imperial College, London.)





The ability of substituted methane molecules to diffuse through zeolite molecular sieves is reduced when hydrogen is replaced by bulky bromine atoms. Monobrominated methane can diffuse through zeolite structures like that of sodium-mordenite with a pore diameter of about 4.0 Ångström Units, while tribromomethane cannot permeate Ca-rich chabazite, with 4.9 Ångström pores.



germanium atoms are tetravalent and contribute no net electrical charge to the framework, but each trivalent aluminum or gallium atom imparts a negative charge. Negative charges localized within the framework are neutralized by metal or hydrogen ions within voids in the crystalline structure. These readily undergo exchange with other cations.

Exchange of metal ions sometimes exerts a profound influence on the ability of organic molecules to diffuse into the zeolite structure. These cations may occupy sites adjacent to apertures leading from one void to the next, and can thus bar the passage of many kinds of molecules.

Dimensions and properties of intracrystalline pores can be chosen so as to exclude bulky molecules. In this way, zeolites function as molecular sieves. But in addition, zeolites can be used to separate molecules of similar size and shape because they selectively adsorb polar molecules. Strong local electrostatic fields are produced by negative charges on the intracrystalline framework and positively-charged exchangeable cations. These fields interact with dipolar molecules, and lead to strong electrical field gradients which interact with molecular quadrupoles. Nitrogen, a diatomic molecule with a considerable nuclear quadrupole moment, is thus bound within zeolite pores more strongly than oxygen, another diatomic molecule of about the same size.

The environment within pores of the zeolite structure can accelerate chemical reactions. In hydrogen-zeolites, some catalyses are thought to occur at H-O- groups bound to silicon atoms on the crystalline framework. These act as acid centres which transfer hydrogen ions to "guest"

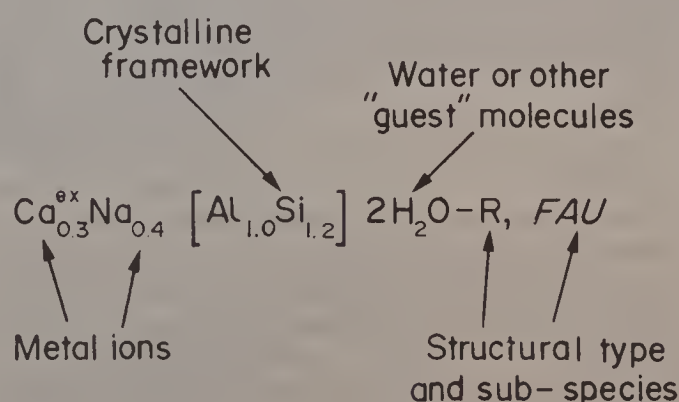
hydrocarbon molecules, forming highly reactive carbonium ion intermediates which may then undergo polymerization, isomerization or cracking before returning hydrogen ions back to the zeolite structure. Catalysis is specific for those chemical reactants which can migrate to active sites. In this way, the functions of molecular sieve and catalyst are harnessed simultaneously.

The properties of a zeolite depend largely upon its composition, structure and exchange of ions. These must all be specified to represent a natural or synthetic zeolite. A systematic method of representing zeolite formulae has only recently been approved in definitive form and published by the IUPAC Commission on Colloid & Surface Chemistry. The report, *Chemical Nomenclature and Formulation of Composition of Synthetic and Natural Zeolites*, was prepared by the noted authority on zeolites Prof. R. M. Barrer of Imperial College, London. Prof. Barrer has also recently authored a book, *Zeolites and Clay Minerals as Sorbents and Molecular Sieves* (1978, Academic Press).

The new rules recommend that the composition of the zeolite framework should be indicated within square brackets. Elements comprising the framework should be listed in alphabetical order, except that oxygen should be indicated last. Oxygen need not be indicated in abbreviated formulas since the number of framework oxygen atoms is always twice the total of other atoms of the framework.

Metal ions not forming part of the framework are usually fairly mobile, and can undergo exchange with other ions. These are shown in alphabetical order preceding the square brackets. The zeolite formula normally represents the

A typical zeolite formula indicates its composition and crystal structure. Subscripts in the formula are relative to one electrochemical equivalent of metal ions. Several types of metal ions may be present, some of which have been introduced by ion exchange. Composition of the structural framework is often abbreviated, as here, so as not to indicate oxygen. The number of oxygen atoms in the framework is always twice the total of metal ions.



composition corresponding with one electrochemical equivalent of these cations, or with the unit cell content.

The structural type is designated by 3 capital italic letters following the square brackets (except for a few well-known notations which have already been accepted). New structural types that may be synthesized in the future should be designated by an official committee after evidence of structure

determination is submitted. Within each structural type, there may be several subspecies resulting from differences in composition, and this too is indicated after the square brackets.

Complete information on representing the structure and composition of zeolites is provided by the report, published in the May 1979 issue of *Pure & Applied Chemistry*.

## Unusual solubility behavior aids testing and purification of lead

The analysis of trace metals in lead poses special problems. Lead binds strongly with common chelating agents, and interferes with standard techniques for preconcentrating metal impurities. Consequently, analysis of impurity metals in lead solutions is best carried out by removing lead salts from solution. This contradicts a general rule-of-thumb of trace analysis: avoid precipitation of the main components of a sample.

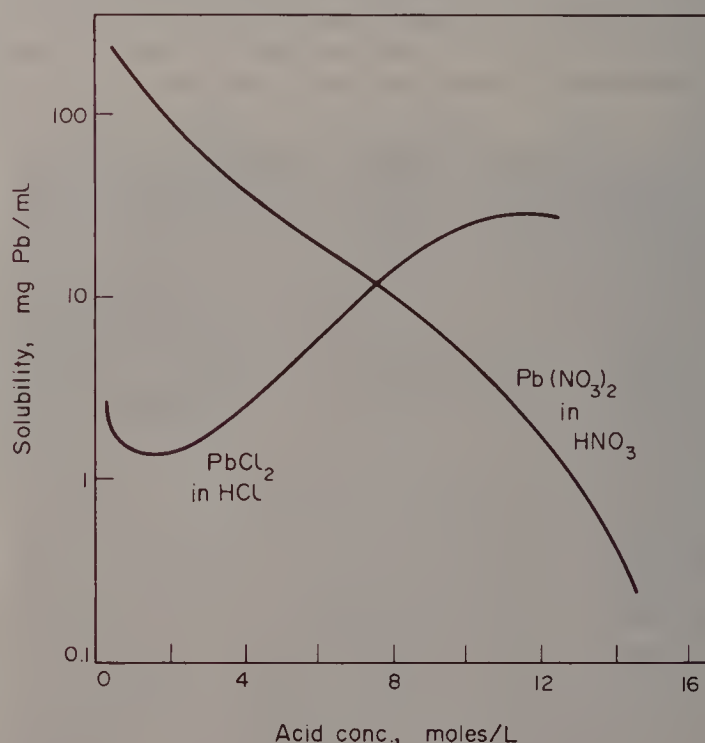
Impurity ions present at the part-per-million level tend to be lost from solution by adsorption onto the surface of precipitate particles, or trapped in the crystal lattice of the precipitate.

But lead is a unique element with unusual solubility characteristics. Lead nitrate is normally considered a soluble salt, but dissolved in nitric acid, its solubility falls drastically as concentration of the acid is increased. This property is very unusual; apparently only strontium and barium nitrate behave similarly. The solubility of lead nitrate in concentrated nitric acid is only one-thousandth of its solubility in water. This allows one simple reagent—nitric acid—to dissolve a sample of lead alloy *and* precipitate pure lead nitrate from solution. Trace metal impurities remain in solution, from which they can be analyzed by routine atomic absorption spectroscopy. The growth of well-formed lead nitrate crystals during evaporation of the solution minimizes adsorption and co-precipitation of impurity metal ions. More than 95% of most trace elements remain in the solution.

Indeed, precipitation of lead nitrate is not only suitable for analyzing impurities in lead, but also for the purification of lead. This is pointed out by Ewald Jackwerth, in a report "Methods for multi-element preconcentration from pure lead by precipitation of the matrix" published by the IUPAC Commission on Microchemical Techniques & Trace Analysis (*Pure & Applied Chemistry*, No. 5, 1979). This report surveys various methods of precipitating lead and concentrating metal impurities for trace analysis. Accepted methods precipitate lead from solution as either the chloride, sulfate, or nitrate salts. But comparison of these methods leads Prof. Jackwerth to conclude that precipitation in nitric acid is the most suitable method for multi-element analysis of impurities in lead.

This is surprising. It would seem that lead could best be precipitated as the sulfate salt, whose solubility is 10–100 times less than lead nitrate. However, lead sulfate precipitates as fine-grained particles, which co-precipitate trace elements and adsorb some metal ions on its negatively-charged surface. For some trace elements, 25% or more are trapped on/in the precipitate, and this loss varies from one analysis to the next.

Precipitation of lead nitrate offers other advantages as well. Nitric acid, even with numerous particles of lead nitrate precipitate, can be rapidly evaporated without splattering at temperatures slightly below the boiling point. By comparison, other concentration methods are difficult and time-consuming. Precipitation of lead nitrate only appears to be inferior to lead chloride precipitation when the analyst needs to determine the content of antimony, gold and most platinum group metals.



**Lead testing and purification procedures can utilize the high solubility of lead nitrate in dilute nitric acid; low solubility in concentrated acid.**



# Major changes in food and fibre production will follow rising CO<sub>2</sub> levels in air

Steadily increasing levels of carbon dioxide in air might significantly influence agricultural production in the 21st century. Research studies in the USA, Sweden and Australia indicate that carbon dioxide concentration in the atmosphere is rising at a slow, but steady, rate. During the decade 1959–1969, levels of atmospheric carbon dioxide rose by a total of 6.8 ppm. If this rate continues into the next century, carbon dioxide levels in the air will rise well above the present 300 ppm.

This is expected to change global climate conditions, since carbon dioxide absorbs infrared heat radiated from the surface of the earth. Not all meteorologists agree on what the effect will be. Many think that it will cause a 2–3°C rise in average temperature, raise the sea-level, and alter rainfall. Other meteorologists dispute this, claiming that the earth is destined for a colder climate.

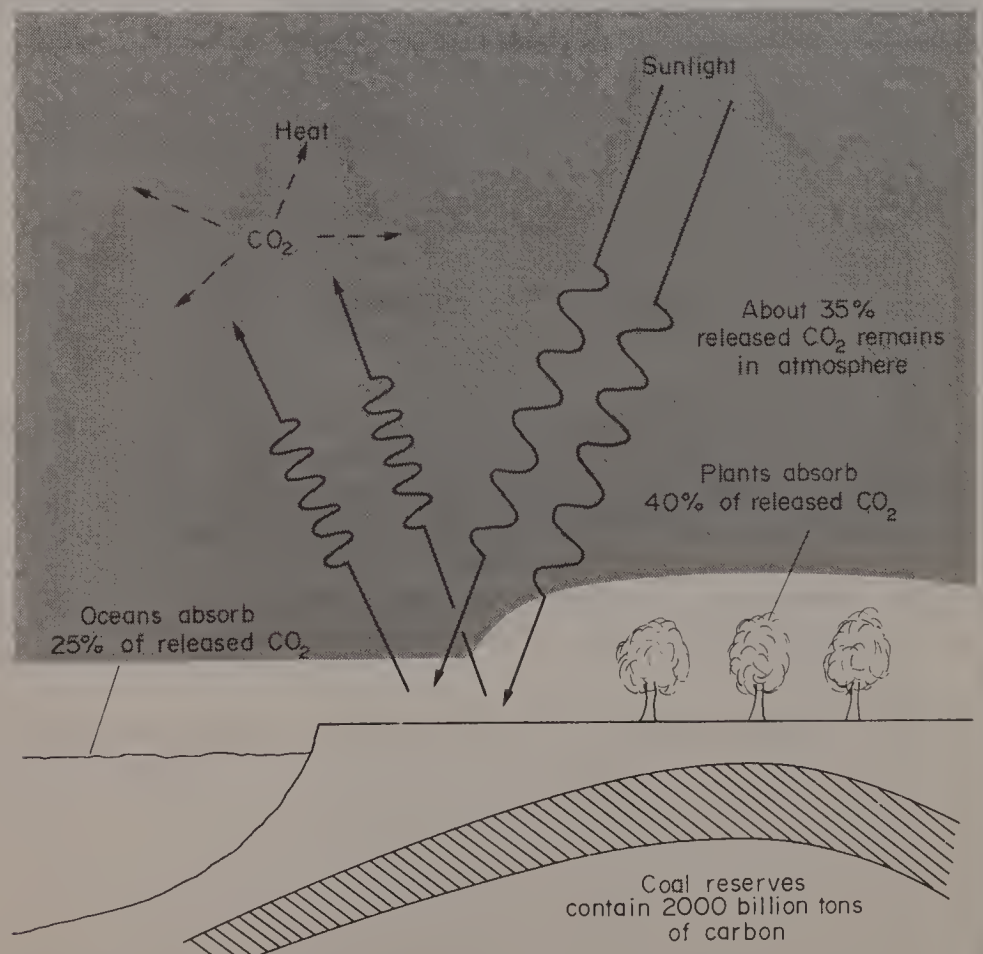
What is clear now is that higher levels of carbon dioxide will affect the growth of agricultural crops in a very substantial and predictable way. Recent experimental results (described in the 1977/78 Annual Report of the Commonwealth Scientific & Industrial Research Organization, Australia) show that enhanced levels of carbon dioxide stimulate crop growth, as was expected. But surprisingly, acceleration of

plant growth is proportionately greatest in crops which receive insufficient water or sunlight. Many countries, like Australia, have vast areas of semi-arid farmland, and could conceivably benefit from the increasing carbon dioxide content of the global atmosphere. However, agricultural gains resulting from higher carbon dioxide levels could be offset by a warming of the climate or decline in rainfall. The net result could actually be a decline in production.

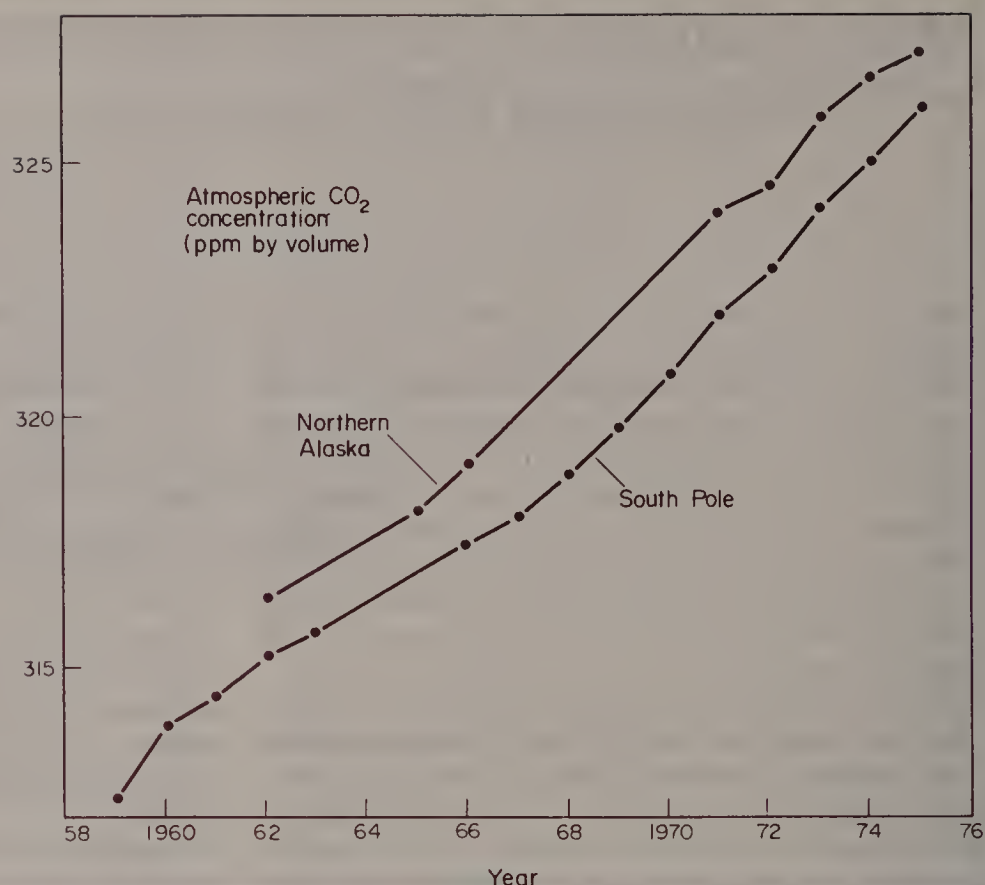
Crop yields in Australia's wheat belt are presently limited by water supply, and the CSIRO report notes that higher carbon dioxide levels could significantly promote grain output. In one experiment, crop yield was *doubled* when Australian researchers elevated the carbon dioxide concentration in the air around the crop by 60%. Normally, photosynthesis depletes the carbon dioxide content of air surrounding a wheat crop by up to 15%. Variations in wind speed and direction change the distance that air travels over vegetation, and could account for daily variations in plant growth.

What is the cause of increasing carbon dioxide levels in the atmosphere? Apparently, it arises from clearing of forestland, burning of fossil fuels, and possibly, long-term natural events. Clearing of trees reduces the ability of forests to fix carbon dioxide by photosynthesis, and also

Infrared radiation emanating from the earth's surface is absorbed by carbon dioxide, heating the atmosphere. Carbon dioxide is nearly evenly distributed throughout the atmosphere above a relatively shallow surface layer.



Rising levels of carbon dioxide in the Southern hemisphere lag about 2 yr behind CO<sub>2</sub> levels in the Northern hemisphere. Present concentrations are about 10% higher than the 295 ppm (by volume) estimated to have been present in the atmosphere before widespread industrialization. (Graph adapted from the Feb. 1979 Bulletin of the Int'l. Atomic Energy Agency.)



releases carbon dioxide when the wood is burned or decays.

Each year, combustion of fossil fuels liberates about 20 billion tons of carbon dioxide. Of this, it is believed that about 35% remains in the atmosphere, 25% is absorbed by the oceans, and 40% is fixed by photosynthesis.

The atmosphere presently contains about 2500 billion tons of carbon dioxide. Burning remaining reserves of crude oil and natural gas could liberate another 1500 billion tons within the next century. Coal and lignite are expected to be consumed over a longer time span, but their combustion could release 7500 billion tons of carbon dioxide.

The oceans could play a vital role in removing carbon dioxide from the atmosphere as deforestation curtails land-based photosynthesis. Aquatic plants and fishlife near the ocean surface assimilate carbon dioxide, at a rate which is largely determined by the amount of phosphorus and other nutrients. These are often depleted near the surface and relatively abundant in deeper waters. Interference with biological processes occurring near the ocean surface could thus have a profound effect on the accumulation of carbon dioxide in the atmosphere, and exert a major (but unknown) influence upon the destiny of the earth's population.

### Booklet is available listing current IUPAC projects

Projects now being undertaken by IUPAC groups have been compiled into a comprehensive listing, contained in a booklet which is available free-of-charge from the IUPAC secretariat. Like the previous 1977 edition, the booklet provides the title of each project, the individual who coordinates it, expected completion date, and other comments about each of the 400 or so projects undertaken by IUPAC's Commissions and permanent committees. To obtain your copy of the booklet, write the IUPAC secretariat, attn: Mr. P. D. Gujral, Bank Court Chambers, 2-3 Pound Way, Cowley Centre, Oxford OX4 3YF, UK.



# Metal impurities are detected with 100× more sensitivity after preconcentration

Widespread use of modern spectroscopic instruments has made possible routine analysis of metal impurities at trace concentrations, but it has not removed the necessity for preliminary chemical treatment of the sample. Some preconcentration methods can increase the concentration of metal ions by 100–1000 times, and extend the detection limit to samples that could not otherwise be analyzed. Perhaps more important, preconcentration can *remove* elements comprising the bulk of the sample. These elements, at a concentration a million-fold greater than the metal of interest, often interfere with spectrochemical analysis. But preconcentration methods are not always applicable, or necessary – and sometimes, not even desirable. When should a sample solution undergo preconcentration? Which methods are most suitable for concentrating a desired metal, or which can eliminate the main element comprising the sample? These questions are addressed in the report *Separation and Preconcentration of Trace Substances (Part I—Inorganic Trace Analysis)*, prepared by the IUPAC Commission on Microchemical Techniques & Trace Analysis.

The report considers general aspects of trace metal analysis, and surveys various preconcentration methods that are available. It cautions that great care must be exercised in choosing a procedure for each particular type of sample. The smaller the sample and concentration to be measured, the greater is the possibility of contamination, the need for pure reagents, and the more critical will be the effects of undesired interactions between sample components.

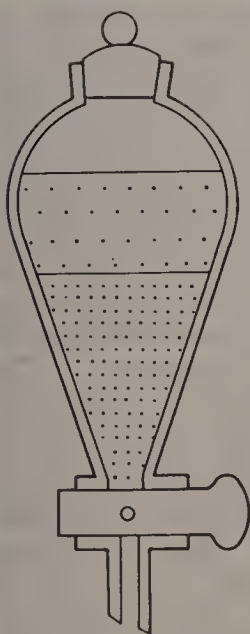
When adapting trace analytical procedures from

the literature, the analyst must consider the range of sample weight and concentration for which the procedure is suited. Possible interactions between the substance to be analyzed and other components of the sample must be considered. A change in the main constituent of the sample (termed, the “matrix”) might, for example, cause the formation of an azeotropic mixture and degrade the recovery yield of the substance to be determined. Or, it might reduce the preconcentration coefficient, the degree by which the trace metal is concentrated *relative to the main component*. This is an important criteria of the effectiveness of the preconcentration step.

There is no universal method of preconcentration. Each has its advantages, limitations, and most appropriate field of application.

The most important and widely used preconcentration method is liquid–liquid extraction. It utilizes the different solubilities of trace metal compounds and the matrix, and the way they are distributed between two immiscible liquids. The method is simple, rapid, and may be automated fairly easily. However, extraction is often limited by a relatively low preconcentration coefficient. Repetitive extractions between a moving and a stationary liquid phase, the basis of extraction chromatography, provides a greatly enhanced preconcentration coefficient.

Another chromatographic method relies on preferential sorption by a solid adsorbent. Most gas chromatographs contain a detector as well as a separation column, and undertake both preconcentration *and* analysis of a sample. Other such “hybrid” methods, in which separation of the



## EXTRACTION

### REMOVAL OF MAIN COMPONENT:

Arsenic (as  $\text{AsBr}_3$ )  
Gold (as  $\text{AuCl}_3$  or  $\text{AuBr}_3$ )  
Iron (as  $\text{FeCl}_3$ )  
Gallium (as  $\text{GaCl}_3$ )  
Indium (as  $\text{InBr}_3$ )  
Palladium (as  $\text{PdBr}_3$ )  
Rhenium (as  $\text{HReO}_4$ )  
Antimony (as  $\text{HSbCl}_6$ )  
Thallium (as  $\text{TlBr}$ )  
Bismuth, Cadmium, Mercury,  
Nickel, Thorium, Uranium,  
Tungsten, Yttrium

### SEPARATE TRACE ELEMENTS FROM:

Alkali metals, Alkali Earth Metals,  
Aluminium, Beryllium, Cobalt, Chromium,  
Niobium, Palladium, Scandium, Selenium,  
Tantalum, Titanium, Tungsten, Vanadium,  
Zirconium

trace compounds is an inherent part of the analysis, are high-pressure liquid chromatography, extraction-atomic absorption, and extraction-spectrophotometric analysis.

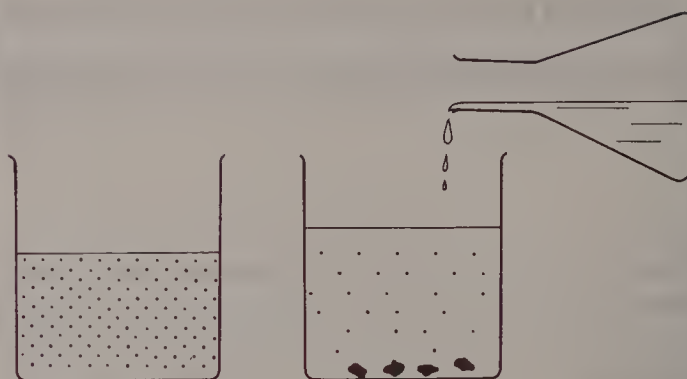
One of the best means of isolating a microcomponent is by precipitation on an organic or inorganic collector. Coprecipitation is very effective at collecting trace materials from large volumes of solvent, and requires only simple equipment. However, this technique generally requires a great deal of time and effort, and consumes large amounts of reagents. As a result, it is rarely used to preconcentrate trace metal ions.

Many analyses involve the indirect determination of elements. In such cases, preconcentration is part of a general sample pre-treatment which alters the chemical form of the trace constituent.

An example is the analysis of phosphorus. Trace amounts of phosphorus cannot be determined directly by atomic absorption spectroscopy or polarography. But phosphorus can be incorporated into 12-molybdophosphoric acid, concentrated in this form, and then determined by analyzing for the molybdenum content. Preconcentration is also an integral part of chemical pretreatment of many biological samples, which are initially decomposed or ashed.

When a trace metal can be converted to a volatile compound, distillation can often be used as a preconcentration step. Distillation is generally simple to carry out, rapid, and provides a high absolute preconcentration.

## PRECIPITATION



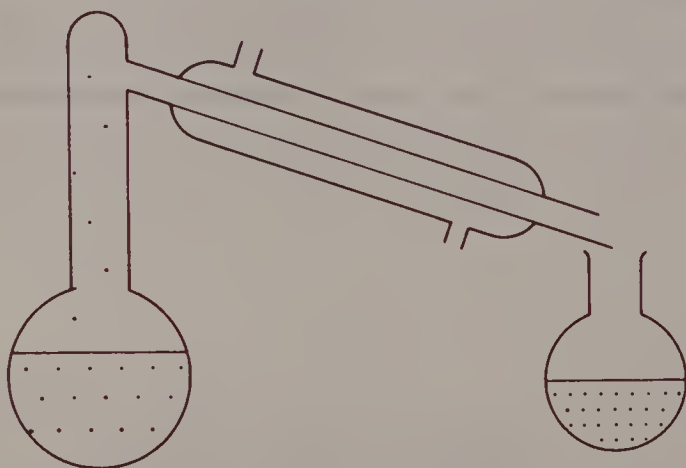
### REMOVAL OF MAIN COMPONENT:

Silver (as AgCl)  
Bismuth (as BiOBr)  
Germanium (as hydrated  $\text{GeO}_2$ )  
Lead (as  $\text{PbCl}_2$ ,  $\text{Pb}(\text{NO}_3)_2$  or  $\text{PbSO}_4$ )  
Tellurium (as  $\text{TeO}_2$ , Te)  
Thallium (as TlI)  
Mercury, Selenium

### SEPARATE TRACE ELEMENTS FROM:

Alkali Metals, Alkaline Earth Metals,  
Cadmium, Copper, Iridium, Lanthanum,  
Magnesium, Molybdenum, Tin, Tantalum, Zinc

## DISTILLATION



### REMOVAL OF MAIN COMPONENT:

Arsenic (as  $\text{As}_2\text{O}_3$  or  $\text{AsBr}_3$ )  
Chromium (as  $\text{CrO}_2\text{Cl}_2$ )  
Germanium (as  $\text{GeCl}_4$ )  
Indium (as InBr)  
Nickel (as  $\text{Ni}(\text{CO})_4$ )  
Osmium (as  $\text{OsO}_4$ )  
Antimony (as  $\text{SbCl}_3$ )  
Selenium (as  $\text{SeO}_2$ )  
Silicon (as  $\text{SiF}_4$ )  
Tin (as  $\text{SnBr}_4$ )  
Vanadium (as  $\text{VCl}_4$  or  $\text{VOCl}_3$ )  
Zirconium (as  $\text{ZrCl}_4$ )

Zone melting utilizes different solubilities of microcomponents in the molten and solid sample. It is relatively simple, requires no reagents, ensures a high preconcentration coefficient, and is easily automated. But zone melting is limited to stable, fusible samples. Even with suitable samples, it requires considerable time, and is susceptible to contamination leached from the container wall by the molten sample material.

Other methods are well suited for the preconcentration of a few particular trace elements. A notable example is the electrodeposition of copper. At the voltage required to electrolyze nearly all copper from a solution, almost all other metal ions remain in solution.

A few common preconcentration methods, and the metal ions for which each method is suited, are outlined with this article. More complete information is provided by the IUPAC Commission report, which appears in the May 1979 issue of *Pure and Applied Chemistry*. The report refers to 90 publications which provide detailed procedures.

Contamination is always a consideration with preconcentration methods, and efforts are required to keep contamination within acceptable limits. Contamination is generally not reproducible, and is difficult to measure accurately. The extent of contamination introduced during treatment of the sample can often be estimated with a "blank run", an analysis using the same procedure under the same conditions and at the same time—but without the sample. However, a blank cannot duplicate *exactly* conditions present with the sample. For example, corrosive samples may leach containers



used in the sample treatment, an effect which is not duplicated by the blank. It may be necessary to prepare samples with known composition, or even use radioactive tracer elements.

The radioactive tracer technique is the best way of determining if there is a loss of microcomponents during preconcentration. A radioactive isotope of the element being concentrated, is added to the sample before the preconcentration step. The presence or loss of the labelled compound can be monitored continuously. This technique offers a great advantage in that recovery is evaluated independently of contamination. Unfortunately, it is often difficult to introduce a radioactive tracer into a solid sample, and artificial samples containing the radioactive isotope must sometimes be used.

## ION EXCHANGE

### REMOVAL OF MAIN COMPONENT:

Cobalt, Iron, Iridium, Manganese, Molybdenum, Niobium, Platinum, Rhodium, Tin, Thallium, Tungsten, Titanium, Uranium, Zinc

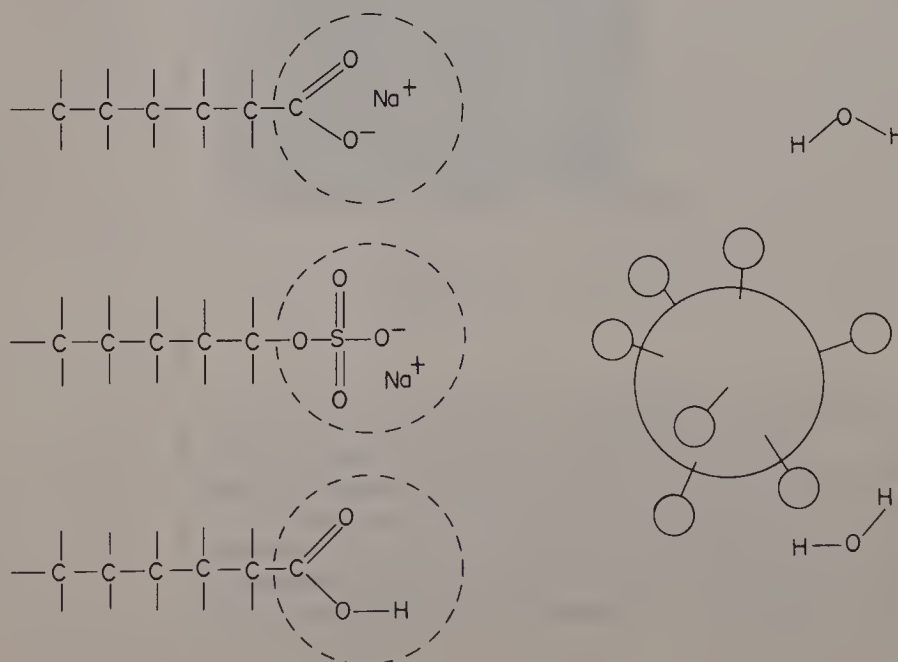
Besides the danger of contamination, preconcentration has other shortcomings. It usually lengthens the analysis, and frequently complicates it. Reagents of high purity are needed. But in many cases, the tremendous gain in sensitivity and accuracy more than compensates for these drawbacks.

## Solution properties change abruptly when critical level of surfactant is added

Surfactants are clearly one of the most widely used types of non-reactant chemicals. They have the ability to bring insoluble liquids into intimate contact by forming an emulsion. One of the liquids is dispersed into colloidal droplets, about 0.01–1  $\mu\text{m}$  diameter. Many compounds can act as surfactants, and these can be a nuisance when one is trying to coalesce and separate insoluble liquids, or prevent foaming. When only one liquid phase is

present, the surfactant itself forms colloidal-size units called "micelles". These are spherical or oblong structures containing perhaps 50–70 surfactant molecules. The formation of a colloidal dispersion does not start as soon as the first surfactant is added. A critical amount of surfactant is required for micellation to begin. At this *critical micellation concentration* (cmc), the liquid undergoes a dramatic transition in surface tension,

Any molecule with an ionic or polar polar group (indicated within circle) and a non-polar group of the proper size can act as a surfactant. A few obvious examples shown here are soaps, alkyl sulfonate detergents, and carboxylic acids. Non-polar groups of the surfactant molecules attract each other to form micelles, non-polar "islands" surrounded by a polar envelope. In an emulsion, the non-polar segment of the surfactant molecule is attracted to droplets of non-polar liquid (depicted on right).



electrical conductivity, osmotic pressure, light scattering and other physical properties.

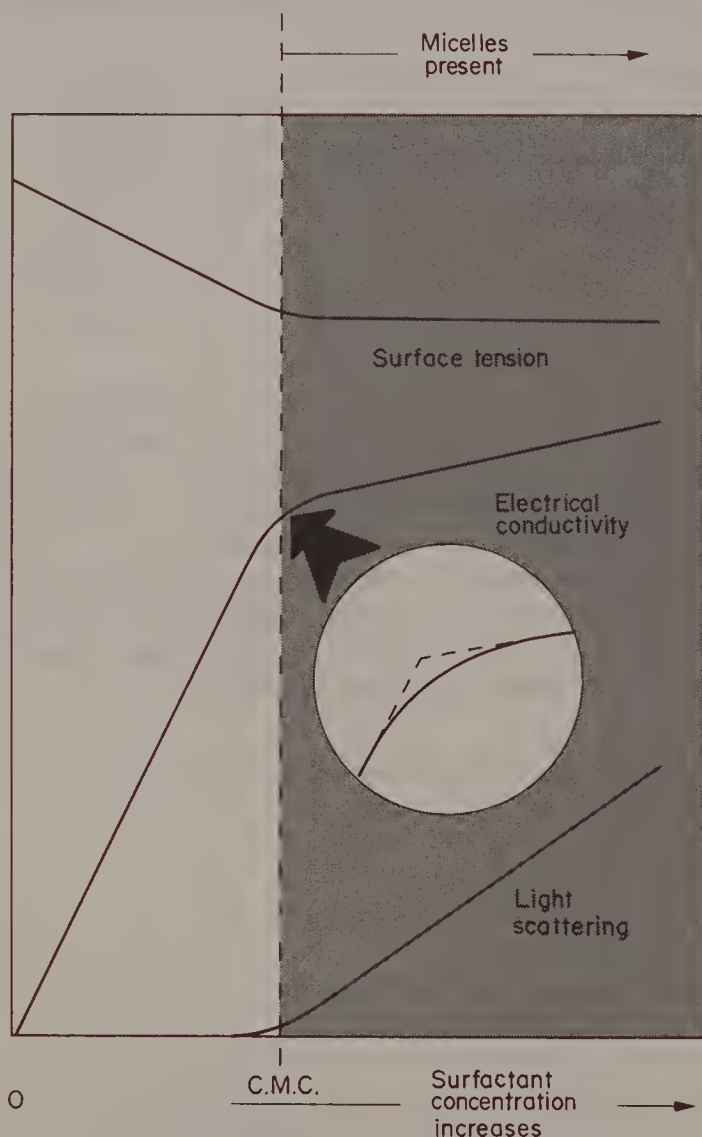
When surfactants are present at very low concentrations, the molecules migrate freely through solution. Surfactants dissolve in aqueous solutions because the polar group within the surfactant molecule interacts favorably with the dipole moments of surrounding water molecules. But surfactant molecules also contain a non-polar hydrocarbon group, and one can imagine that water molecules surrounding the hydrocarbon segment of the surfactant would find this environment very undesirable from an energy standpoint.

If the concentration of surfactant is allowed to increase beyond the critical micellation concentration, a rapid shift occurs in the equilibrium between solution and micelles. In aqueous solutions, surfactant molecules align within a micelle so that non-polar groups project inward, away from water molecules in solution.

The transition from a dilute micelle-free solution to a micelle-containing solution is distinct and spontaneous, but does require a finite addition of surfactant. Furthermore, the value of the critical micellation concentration is altered by other compounds in solution. Sugar and other hydrophilic ("water-loving") compounds generally exert little effect, while non-polar compounds may significantly reduce the amount of surfactant required to bring about micellation. Despite these difficulties, a carefully measured cmc *can* refute the identity or purity of a compound if it differs greatly from a reliably reported value.

Early measurements of cmc's noted the surfactant concentration at which micelles were first formed, as indicated by the onset of turbidity, or the onset of a sudden change in surface tension, conductivity, or osmotic pressure. But the ability to detect small changes in these physical properties varies with the sensitivity of the measurement techniques. Now, a new strategy for measuring and defining cmc's is recommended by the IUPAC Commission on Colloid & Surface Chemistry. They analyzed how graphical data could be interpreted for most accurate results, and presented their conclusions in the report, *Reporting Experimental Data dealing with Critical Micellation Concentrations of Aqueous Surfactant Systems* (published in *Pure & Applied Chemistry*, May 1979). It recommends that changes in physical properties (resulting from increased surfactant concentration) be monitored up to, and above, the apparent critical micellation concentration. The rates of change before and after the onset of micellation are then extrapolated to determine the critical micellation concentration. For example, a graphical plot of electrical conductivity shows a second-order change at the cmc, which is precisely determined by extrapolation.

Studies of micellation and surfactant properties will likely have benefits for laboratory and industrial chemists. Surfactants have always been an important consideration in synthetic organic chemistry. Most organic compounds are immiscible with water, but yet, these must often be reacted or washed with aqueous solutions. One application of surfactants has become prominent only very recently: paints. Conventional paints with organic solvents are now considered environmentally undesirable because toxic hydrocarbon vapours are released into the air as the paint dries. A general trend towards water-based paints is now in progress. This has required new techniques to be developed to emulsify polymer resins (which form the tough film holding the pigment) in a solvent consisting mostly of water. Even epoxy paints, which polymerize after application without solvent evaporation, are now produced as water-based emulsions with a suitable consistency to be applied by brush. Formerly, the most practical means of applying highly chemically-resistant epoxy coatings was by spraying.



Surface tension, electrical conductivity and turbidity of a solution undergo an abrupt change when micellation begins. The amount of surfactant that must be added to reach that point, the c.m.c., was previously determined by noting the onset of micellation. The procedure advanced by IUPAC determines the crossing point of graphical data from below and above the c.m.c.



## A burning question

What happens inside a flame? With the aid of sophisticated instruments, it has now become possible to probe the chemical constituents of flames and, for the first time, get correct results. The conclusions are surprising, and contradict even relatively recent studies using conventional techniques. For example, it was thought until very recently that nitrogen dioxide ( $\text{NO}_2$ ) is formed during early stages of combustion, together with nitric oxide ( $\text{NO}$ ). That conclusion was based upon analysis of gas samples withdrawn through a suction probe inserted into a flame. No so, according to researchers at the CSIRO in Australia. They report (in the 1977–78 Annual Report of the CSIRO Mineral Research Laboratories) that  $\text{NO}_2$  is not present *in* flames, but is generated by reaction of free radicals with  $\text{NO}$  *after* the gases leave the combustion zone. The CSIRO researchers used a laser to excite fluorescence of molecules within the flame, and after time-averaging the results by computer, found that  $\text{NO}_2$  wasn't present. In doing so, they roasted the existing belief on flame chemistry. Well done.

The concentration of ions in flames is about a million times less than that of free radicals – a concentration so low that ions cannot play a significant role in most combustion processes. However, the charge of an ion allows it to be readily extracted from flames, and the ion identified in a mass spectrometer. By monitoring ions in flames, information can be obtained more readily about free

radical precursors than by direct measurement of free radical concentrations.

Mass spectroscopists at the CSIRO Division of Chemical Physics examined ions present in a flame to gain greater insight into the operation of flame ionization detectors. They studied a flame formed by combustion of hydrogen, containing a trace of organic additive. This would closely simulate the type of gas burned in flame ionization detectors used in gas chromatography. What they found with their specially modified “flame ionization mass spectrometer” is intriguing, and might apply to combustion of other types of gas streams.

Each of the three visible regions of the flame contained characteristic, and different, positive ions. Burnt gases downstream from the flame front contained mostly  $\text{H}_3\text{O}^+(\text{H}_2\text{O})_n$  ion clusters. These are the charge carriers generally detected in flame ionization detectors. But the mass spectrum of gases sampled from the flame front was dominated by  $\text{C}_3\text{H}_3^+$  ions. This same ion was formed regardless of the organic additive burned in the flame. Finally, the researchers noted that gases upstream of the flame front provide a mass spectrum which varies with the organic additive. They state (in the 1977–78 Annual Report of the CSIRO Division of Chemical Physics) that measurement of these mass spectra give information about the combustion mechanism for each organic additive, but are unable to account for the ubiquitous formation of  $\text{C}_3\text{H}_3^+$  ions in the flame front.

# Chemists must respond to technical challenges of survival

Critical challenges must be met if industrialized nations are to maintain their standard of living, and developing nations are to avoid starvation and poverty. Major sociological and technical problems need to be overcome. Some have plagued civilizations for millenia, but are now exacerbated by population growth. Others have never been encountered before. Together, they will require a massive undertaking, whose thrust will be guided by development work in chemical research laboratories.

This article deals with those global problems for which chemists will play a more active role in solving. It is based upon a paper presented by Dr. Bryant Rossiter at the International Symposium on Science & Technology, held in Singapore in January 1979. Dr. Rossiter is chairman of the United States Committee for IUPAC, and of the IUPAC CHEMRAWN committee.

by Dr. Bryant Rossiter

Foremost among the major problems facing humanity in the decades ahead are food supply, nutrition, health, population, availability and access to natural resources, education, human settlements, and nuclear threat. To these we might add what many regard as the most serious of all: social unrest due to increasing disparity between the haves and the have-nots.

The magnitude of these problems is enormous and the consequences of failing to solve them are grim. It is not difficult to imagine the catastrophic changes in lifestyle and upheaval of world economic conditions should we fail to solve the problems of energy or food supply.

Take food supply, for example. The world population, just as Malthus warned, has grown at exponential rates. It was two billion in 1930, three billion in 1960, and today it is already four billion. There may be six billion mouths to feed at the end of this century.

There are serious scholars who forecast starvation of international proportions. Some say it can be averted only by radical redistribution of food from countries having an abundance to those with serious food deficits. There are even a few who have made headlines by suggesting there is just not enough to go around. People whose survival prospects are nil, they say, should simply be allowed to starve.

So we are not without our prophets of doom. But those in research and development who are concerned with resources and their chemical transformations into the materials of life should not be among these pessimistic groups, because they are in a position to make direct contributions to those very areas where man's needs are greatest.

It is chemistry, for instance, which contributes to the latest-generation advances, which makes food pro-

duction in some of the advanced nations the miracles they are. Malthus thought food could not keep up with mouths, because while population grew exponentially, agricultural yields could only grow arithmetically. He reckoned without the fertilizers, pesticides, yield-promoters, and dietary supplements that make the idea of a green revolution possible in place of famine.

Similarly, we know that a number of our major natural resources will be depleted in a little over a lifetime from now. Petroleum is probably the most startling example.

Some authorities point out reserves will not actually be exhausted, and therefore we will not literally run out of oil and other resources. But, they add, the cost of obtaining them will be too high, so the end result will be essentially the same. Whichever position you hold, it is clear that we are living in what has been called the "twilight years" of petroleum.

For anyone who depends on chemistry, this is serious business. In the first place, there are some five million people, worldwide, who are directly employed in petrochemical-based industries. Indirectly, much larger numbers of jobs are dependent upon organic materials supply. In monetary terms, it has been estimated that the output of the organic chemical industry of the world amounts to 300 billion U.S. dollars annually, and it influences nearly one third of the world's gross products. Thus, without alternatives to petroleum feedstock, our societies would have to adjust to a radically different world . . . a world without life-saving medicines, without plastics, without a large quantity of its clothing, without commercial fertilizers to help feed all the hungry of the world. In short, these issues are so serious that one can confidently predict a significant drop in the world's standard of living among the developed nations and an almost complete eradication of the hopes and aspirations of those in the developing nations seeking a higher standard of living. Thus, the list is forbidding



Wood is the primary fuel for cooking and heating in many parts of the world. There is often not enough, and excessive cutting of trees is causing deforestation, erosion and soil loss. Nearly half of world wood production is burned, and usually, less than a tenth of the heat energy is utilized. Simple design improvements in cooking stoves and utensils could increase utilization of heat energy as much as fourfold.

This site, near the Indian village of Akbarpur-Barota was forestland only thirty years ago. As trees are stripped from semi-arid land, soil is lost by erosion, and neighboring desert advances into formerly arable land.



In the absence of wood or charcoal, many villagers are relying to a greater extent upon cattle dung as fuel. Dried dung burns well, and each cow produces enough dung per day to supply the energy equivalent of a half litre of gasoline. However, burning dung destroys its value as fertilizer and contributes to the depletion of the soil.

The introduction of technology promises to alleviate the effects and cause of firewood shortages. Biogas, a cooking gas consisting mostly of methane, is generated by fermenting dung. Its heat of combustion, about 70% that of natural gas, makes it suitable for heating, lighting, or powering engines.



Biogas is produced by placing biological waste into a concrete pit, adding water, and seating a steel gas holder on top. Product gas is piped to nearby households. The remaining slurry is an excellent fertilizer, containing 2% nitrogen, 1% phosphorus, 0.7% potash and 50-75% organic humus. So far, only a small fraction of households in developing countries have been able to afford the initial cost of biogas generators (about US\$200-400), or own cattle and farmland to supply biological waste.

Production of biogas has the potential to provide the Third-World with a closed-cycle renewable energy source within a decade. The technology exists and is ecologically sound. More sophisticated technology, now being developed, could also be adapted for digesting agricultural waste into ethanol, butanol or acetone fuels. But technology is not the only requirement for success. Villagers must cooperate in operating community energy supplies, which are more efficient than individual household biogas generators. And Third-World governments must ensure that the benefits of advanced technology are not limited to those with cattle and land.

*(Photographs from Earthscan, the Int'l. Institute for Environment & Development).*

and endless, from the necessities of life to some of life's most rewarding pleasures. Although the problems are staggering, the opportunities for solution are great, and fortunately there is, in the case of new energy resources, time to manage the problem rationally providing actions are initiated now. Otherwise, forms of discipline will be required among the nations which in the past have only been achieved in times of war.

Chemistry can be considered as perhaps the most utilitarian of all sciences. It is the thread from which modern society is woven — namely, chemical materials and their transformation. Those associated with the chemical disciplines are in a sense weavers before the loom. And since humanity lives in a material world, these weavers will in many ways determine the future fabric of our society. In fact, it is imperative that those associated with the chemical disciplines play this role.



One scientific institution that has played a major role in the organization, systematization, development, and advancement of chemistry and chemical technology is the international Union of Pure and Applied Chemistry. IUPAC is the largest and perhaps the most important of the international scientific bodies . . . IUPAC is an international, non-governmental, nonpolitical organization having available to it through its National Committees in many countries the best available world expertise in chemistry and chemical technology. IUPAC has played an important part in virtually every facet of chemistry and chemical technology since its organization sixty years ago.

But the world of 1978 is vastly different from the one of 1919. Problems which were thought then to be of interest only to chemists are now of interest to entire societies. Moreover, the public's view of chemistry and its practitioners has changed rapidly over the past decades. Chemists who were once considered miracle workers developing new drugs, fertilizers, and pesticides that led to the green revolution, suddenly have become the polluters of the environment, makers of napalm bombs, and purveyors of toxic chemicals.

Many chemists themselves have a narrow view of their mission and responsibility to society. One noted scientist gave this picture of IUPAC: "In spite of its great prestige and international importance, chemists of the world don't exactly flock to IUPAC meetings to learn the newest in problem-solving applications of chemistry. Instead, they look to IUPAC as a convenient place to share the news in fundamental chemistry". He went on to suggest that even when fundamentals were uncovered incidentally to applied programs, the fundamentals got most of the attention nonetheless. In his opinion IUPAC was really the international Union of *Pure* Chemistry with "Applied" only as an afterthought.

In fact, however, IUPAC, through its Division of Applied Chemistry, sponsors frequent commissions, studies, and symposia relating to applied chemical problems. And those working within the organization recognize that it has an important role to play in applying chemistry to world needs. The question is how can this best be done.

One suggestion that emerged from the IUPAC Council meeting in Munich in 1973 was that there be a new mechanism in IUPAC, a mechanism whereby member nations could aid in identifying and solving important chemistry problems that have a direct impact on world needs. The general idea was unanimously approved and out of this grew CHEMRAWN, Chemical Research Applied to World Needs.

It was not proposed that IUPAC undertake research of its own; rather, it should provide leadership and a badly needed independent, nonpolitical, central forum for the discussion of critical needs and solutions under conditions that otherwise might be impossible. In addition, it was envisioned that CHEMRAWN activities would provide the basis for treating chemical-based human needs as systems, not just the isolated technical components involved. Thus, CHEMRAWN conferences by their very nature would be highly interdisciplinary, taking into account social, economic, environmental, and political factors also. It was planned that these international conferences

would involve world leaders from governments, industries, and academic and that the goal and focal point of these activities would be an attempt by recognized and influential world leaders to take an initial step toward developing a sense of future direction that would be of value to the world chemical community. These recommendations would be set forth in conference proceedings and would be made available to participants and policy makers in governments, industries, and academic institutions worldwide. Further, it was determined that future conferences or other forms of action would be taken to ensure continuity in areas where there was a continuing need.

IUPAC's initial enterprise under CHEMRAWN was the first "World Conference on Future Sources of Organic Raw Materials" held in Toronto, Canada, 10-13 July, 1978. Approximately 800 experts from 48 countries attended. The Organizing Committee and attendees included not only internationally recognized technical experts but also board chairmen, presidents, vice-presidents, and research directors from industry; world banking leaders; advisors to top governmental officials; and other high-ranking and influential people. In short, it was an interdisciplinary meeting of experts and decision makers where the purpose of the conference was to define and set in perspective those factors that will ultimately determine the sources of organic raw materials necessary to supply world chemical industries at the end of the century.

An 11-page executive summary containing specific recommendations was published and delivered by key conference attendees to important decision makers in governments, industries, and academic institutions. A bound volume of the complete proceedings, including the summary and recommendations, is available to participants and other interested parties through the Pergamon Press.

The next CHEMRAWN meeting will treat chemistry, agriculture, and world food supplies and will be held in Manila, Philippines, in March, 1981.

CHEMRAWN represents a bold new initiative for the chemical profession. The purposes of CHEMRAWN and the resources of IUPAC are obviously limited. They cannot do everything about everything, but they can do something about many things, and this is what they are attempting to do.

The world is now truly turning its attention to questions for which chemistry has the opportunity and the obligation to find answers. But these answers without proper political and social action are meaningless. It is vital, therefore, that these elements work closely together with chemical science and technology to extend the benefits of modern technology to all the earth's people. IUPAC, through its new CHEMRAWN initiative, should be prepared to address itself to world problems which can be ameliorated by the applications of chemistry and chemical technology, including the transfer of science and technology to developing countries. To this end, IUPAC should work cooperatively with governments and appropriate international organizations toward these common objectives. Accordingly, we see CHEMRAWN as an effective international vehicle to address important areas in a world context in an ongoing and cooperative manner.



# Cadmium surfaces worldwide as a new pollution danger

The significance of cadmium as an insidious poison has remained unrecognized until recently, when potentially dangerous levels were discovered in food, water and soil in contaminated areas on three continents. Cadmium is now considered to rank in importance with mercury as a toxic metal contaminant.

Cadmium is readily accumulated by plants and animals. In man, it produces a wide range of apparently disconnected, and chronically debilitating effects. This is one reason why its toxicity has been so neglected compared to mercury, lead, and other well-known heavy metal poisons. Cadmium can be biologically damaging at low levels, even though it induces no immediate effects. But once absorbed by the body, cadmium is tightly retained. It accumulates in body organs, where it remains for an estimated half-life of 15–30 yr.

Seven years ago, one investigator noted that cadmium is "poorly understood biologically – and grossly under-investigated as an environmental contaminant". This description is still true, but likely to change now that the danger and extent of cadmium pollution are gaining recognition at last.

by Dr. Martin Gellender  
Editor  
and Dr. P. S. Lake  
Senior Lecturer, Monash Univ.

The very nature of cadmium predisposes it to be a pollution problem. It occurs naturally as a minor component of metal ores, safely contained in rock beneath the earth's surface. When the rock is mined, it is brought to the surface on a one-way journey. Its eventual use in metal coatings, pigments, alloys and solder means that wear and corrosion will gradually release cadmium to the environment. Virtually no recycling of cadmium is carried out, in contrast to metals such as iron, copper and lead. By its very use in society, cadmium is continuously released to the environment.

Far more serious than the gradual release of cadmium is the exposure of industrial workers and the public to localized high concentrations. Workers in scrap metal yards, smelters, plants producing cadmium pigments, and welders can be exposed to cadmium oxide dust. It is thought that 10–40% of inhaled cadmium dust is absorbed into the human body. Excessive inhalation causes chronic bronchitis, emphysema and kidney disease.

The general public can be exposed to cadmium through their food supply. A dramatic illustration is an outbreak of "itai-itai" disease (acute cadmium poisoning) which occurred in Japan. Food and drinking water were contaminated by cadmium released into the Jintsu River by the Kamioka Mine of the Mitsui Mining Company. Inhabitants of the area suffered irreversible kidney damage, severe pain in the back and joints, and bone fractures. Most victims were women who had reached menopause and had borne several children. Although the disease was first

noted in 1946, it was not until 1968 that it was officially recognized as chronic cadmium poisoning. Within recent years, cadmium poisoning has been reported among residents of the Ichi River Basin, polluted by a zinc-copper-lead mine, and in the cadmium-polluted Kakehashi River Basin. Over one-thousand cases of "itai-itai" were reported from 1962 to 1974, with 49 deaths. The seriousness of the problem in Japan was apparently exacerbated by lack of calcium in the diet. The uptake of cadmium is inhibited by calcium (an essential component of the human diet).

When cadmium is absorbed into the body through contaminated food, water, or inhaled dust, it is transported through the blood and collects in the kidney and liver. While trace amounts of some heavy metals are necessary in the diet (indeed, zinc and copper are essential), there is no evidence that *any* amount of cadmium, mercury or lead is desirable.

Cadmium pollution has not been restricted to Japan. Only this year, there has been a public outcry following the disclosure that residents of the UK village of Shipham (near Bristol) have about 10 times the normal concentration of cadmium in their bodies. The town is built upon tailings of a former zinc mine, which has been closed for decades. Cadmium concentrations in the soil are very high, and this is believed to cause a high cadmium content of locally-grown vegetables.

Residents of the UK village are being given an examination to determine the content of cadmium in their livers by Neutron Activation Analysis. Of those residents examined initially, about 60% had 20 ppm or more cadmium in their liver (reflecting a kidney concentration of about 200 ppm). A kidney concentration of 100–200 ppm is likely to cause kidney damage in human beings. By comparison, normal



individuals have about 2 ppm cadmium in their liver. Cigarette smokers have about 2½ times this level, due to cadmium oxide in tobacco smoke.

Zinc refining is the source of severe cadmium pollution in the Derwent Estuary in Tasmania, Australia. Concentrations of toxic metals in sediments around the zinc refining plant are among the highest ever encountered anywhere in the world. The high concentrations of cadmium, zinc and lead at the plant wharf was probably caused partly by spillage of ore concentrates, but the 1100 ppm of mercury measured near an effluent pipe indicates that some toxic metals salts were discharged directly with other metallurgical wastes. Cadmium concentrations in the estuarine sediment near the plant wharf were as high as 1400 ppm.

As a result of these metal discharges, commercial oyster beds have been condemned for human consumption. Oysters downstream of the Derwent Estuary had collected cadmium in their tissues to a concentration of 35 ppm, or when dried, up to 200 ppm. This is comparable to the 120–350 ppm cadmium level of dried rice from the Jintsu River Basin in Japan, where “itai-itai” disease was prevalent.

There is wide variation in the ability of shellfish to concentrate cadmium, even among closely related species. Edible mussels removed from one site in the Derwent Estuary had accumulated cadmium to a concentration of 19 ppm (when dried), considerably higher than the 0.8 ppm in the water and 2.5 ppm in sediment. Common mud oysters recovered from the same site contained 174 ppm cadmium, while Van Diemen’s Land Siphon (another shellfish) contained about one-hundredth this concentration.

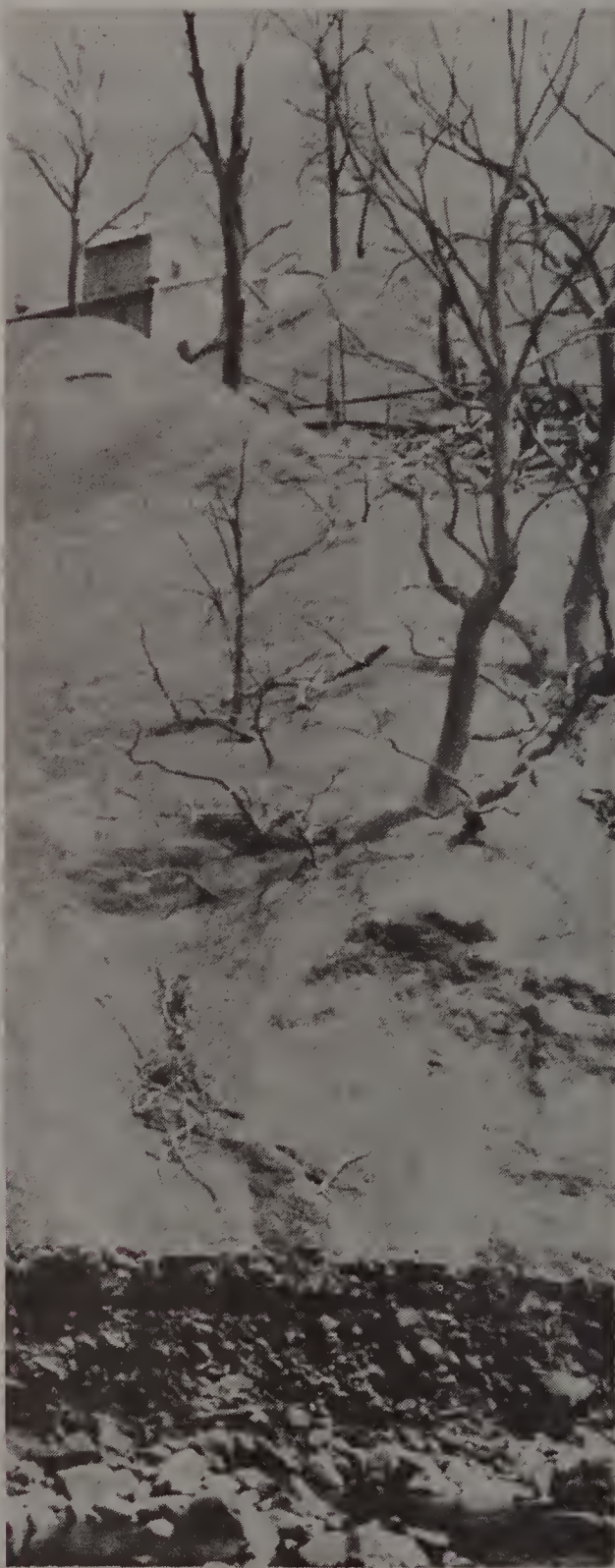
Cadmium uptake by shellfish varies greatly with conditions. It is generally reduced at colder water temperatures. Increased salinity of the water also inhibits cadmium uptake—an effect apparently due almost entirely to the presence of calcium ions in seawater. Animal experiments indicate that cadmium poisoning can be partially offset or prevented by administration of calcium. This appears to be true for humans as well.

Other Australian rivers have been affected by heavy metal pollution as well. The severely-contaminated South Esk River in northeastern Tasmania is the only fresh-water river in Australia where cadmium pollution has been fully studied. It is severely polluted by cadmium and zinc because of mining activity on the drainage basin of the river.

In some parts of Australia, contamination of shellfish with cadmium has been found. Human consumption of molluscs has been banned in parts of Port Phillip Bay, Victoria (near Melbourne), where cadmium levels of dried mussels exceed the 2 ppm limit set by the Australian National Health & Medical Research Council. Cadmium concentrations of oysters are also reported to exceed this limit in the Tamar river in Tasmania.

Waterways are not the only means of cadmium dispersal and contamination. Airborne fallout has caused cadmium contamination of soil and plants near a copper smelter in Wollongong, NSW (Australia) and near a lead–zinc smelter at Port Pirie, South Australia. Another study reported high cadmium levels in soil adjacent to a major highway. Participants in this study concluded that “. . . the accession rate (of cadmium) in soil adjoining busy highways is

**Mining is the primary cause of cadmium pollution in waterways. Minewater at the tungsten mine at Storeys Creek, Tasmania (right) was found to contain 4.3 ppm of cadmium. Residue of ground ore, such as the tailings dump immediately adjacent to Storeys Creek (below), are a main escape route into the environment. Cadmium is leached from tailings by rainwater and carried directly into the creek. Downstream, Storeys Creek (right) is heavily polluted by zinc and cadmium, and devoid of vegetation along its banks. The creek then joins the South Esk River, which is still significantly polluted 45 km downstream from the junction. (All photos are provided by Dr. P. S. Lake of Monash University, Australia.)**









sufficiently large to demand that care is taken to avoid growing vegetables for human consumption too close to such locations''.

In fact, airborne cadmium might prove to be a serious problem in many urbanized areas—including major industrial cities. The highest airborne concentration of cadmium ever recorded was near a lead-recovery plant in the city of London, England. Extremely high levels of cadmium in the air around the plant was discovered by chance. A pollution survey of the area was undertaken to measure lead levels in the atmosphere, soil and dust around the plant. The research team (from the Islington Pollution and Research Unit, and the Central London Polytechnic) subsequently decided to measure cadmium levels as well. Findings of the study were totally unexpected: lead levels gave no unusual cause for concern, but cadmium concentrations in the air around the plant were extremely high, ranging from 0.3 to 11  $\mu\text{g}/\text{m}^3$ . People breathing the most contaminated air would accumulate about 200 ppm cadmium in their liver over a 5 yr period.

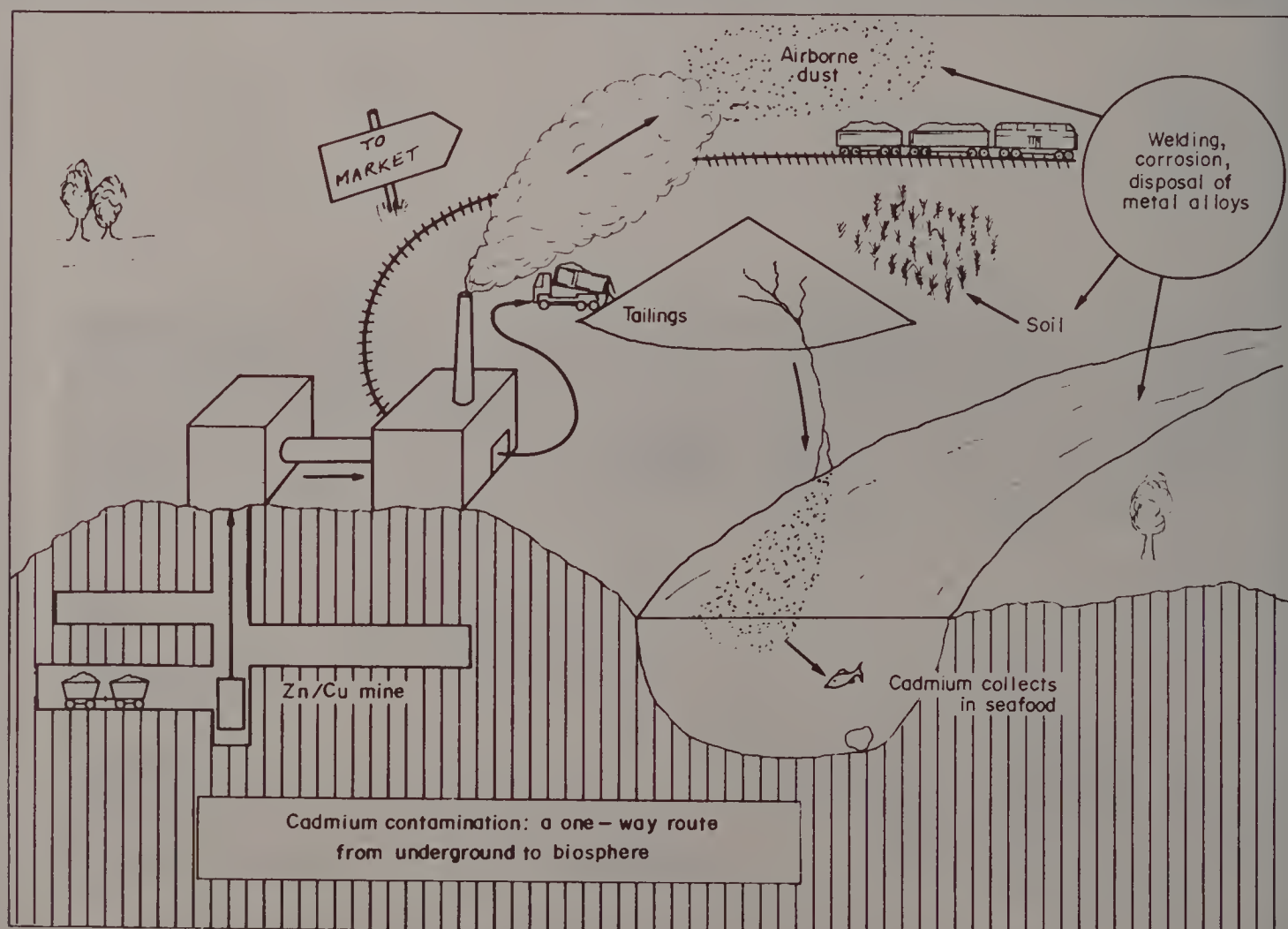
Was cadmium contamination by this one lead-recovery plant unique? Or, is it typical of numerous other secondary metal plants: the London Borough of Islington alone has 24 heavy metal plants. Following publication of the study in 1976, there has been no widespread effort to monitor emissions. There has been little public awareness of this potential problem. This could be starting to change. A short article published early this year in the magazine *New Scientist* reports that the Greater London Council is considering a general survey of the city's scrap-metal plants.

Regardless of the means of dispersal into the environment, through air or water, cadmium and

other toxic metals accumulate in the biosphere. Unlike biological and organic poisons, heavy metals do not degrade naturally in the environment. Some collect in the bodies of animals, becoming increasingly concentrated as simpler organisms are eaten by those further down the food chain. The human body possesses good mechanisms for detoxifying and excreting excess zinc, copper, iron and manganese, but for three toxic heavy metals—mercury, lead and cadmium—there appears to be no efficient natural mechanism for detoxification or excretion. These metals accumulate in shellfish to a much higher concentration than is found in surrounding water and sediments. Man exhibits a very similar biochemical reaction to cadmium as do fish, horses, rabbits and mice. All produce in their liver and kidneys thionein, a type of low molecular weight (6000–10000) protein which has a high affinity for cadmium, zinc and mercury.

Binding of the metal as a metallothionein complex may assist in detoxifying cadmium, allowing the animal to accumulate and withstand high concentrations. The protein is normally absent from human kidney and liver tissue, but is apparently synthesized in response to the presence of cadmium. The extremely high metal-binding affinity of metallothionein may be responsible for the long retention of cadmium in most aquatic and terrestrial animals. About one-third of the amino acids comprising the protein are cysteine, so that each metal atom is bound to three sulphhydryl groups.

More research can be expected to provide better insight into biochemical processes which are induced by cadmium ingestion or inhalation. But clearly, the most logical near-term course in abating the pollution





hazard is to restrict the use and release of cadmium. This will be difficult: cadmium is used extensively in small amounts in metal coatings, alloys, and is a common contaminant of zinc. A serious effort needs to be directed towards substituting other materials for cadmium. In the few applications where recycling is feasible (notably, nickel-cadmium batteries), programs can be established to recover and reuse the cadmium that we introduce into this world.

Further Information

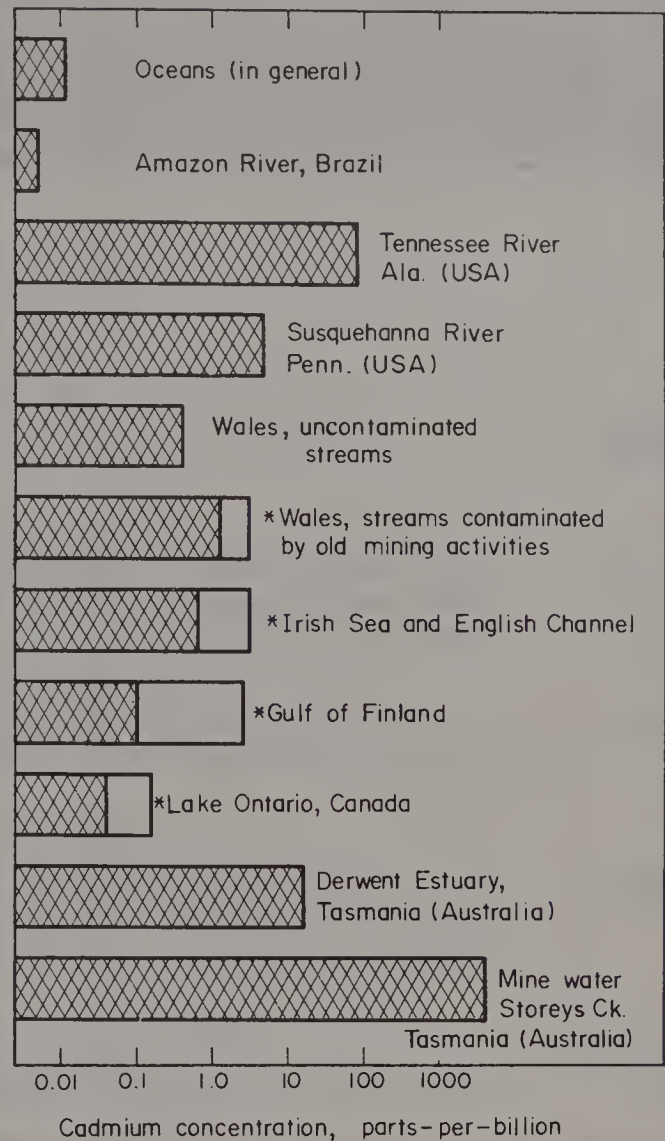
A detailed publication which explores general aspects of cadmium pollution and movement into aquatic ecosystems is:  
P. S. Lake, R. Swain and B. Mills, Australian Water Resources Technical Report No. 37 (1979)  
The report was in press at the time of this writing, and will be available shortly from: Mail Order Sales, Australian Government Publishing Service, P.O. Box 84, Canberra A.C.T. 2600, Australia. The cost is 5 Australian dollars.

Acknowledgement

Cadmium pollution was initially brought to the editor's attention through two independent sources: newspaper coverage and a television newscast about cadmium pollution in Shipham UK, and the article "Accumulation of Cadmium in Aquatic Animals" by Dr. P. S. Lake, which appeared in the January 1979 issue of *Chemistry in Australia*.

This article was prepared by the editor, with background information, suggestions and approval provided by Dr. Lake, a Senior Lecturer in Zoology at Monash University (Melbourne, Australia) who has pursued a long-time interest in heavy metal pollution. For his honours degree in zoology, he undertook a study on the effects of zinc pollution on aquatic invertebrates in the Molongo River in the Australian Capital Territory. His recent interests have focussed on ecological effects of zinc and cadmium, and toxicity of cadmium to freshwater animals. As an expert in his field, Dr. Lake believes that cadmium contamination is more widespread than previously believed. He points out that cadmium is far more toxic than zinc or copper, yet some recent surveys of heavy metal pollution have not even considered cadmium as a contaminant. It has been difficult

Cadmium concentrations found in waterways



\*Unhatched areas indicate range of measured values.  
(Source of data: H. Bloom & G. M. Ayling, *Environ. Geol.* 2, 1977, pp. 3-22.)

to prove that cadmium pollution is a problem, because many of its effects – hypertension, liver and kidney damage – can also be caused by excessive alcohol consumption and cigarette smoking.

# CONFERENCES

IUPAC meetings are indicated in bold type  
Additional information from address in parenthesis

## 1979

### CHEMICAL ENGINEERING

|                     |                                                                                                                                                            |                    |
|---------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------|
| Sept. 30–<br>Oct. 3 | 29th Canadian Chemical Engineering Conference (Dr. J. Changfoot, Esso Chemical Canada Plastics Technology Lab, P.O. Box 69, Sarnia Ontario N7T 7H8 Canada) | Sarnia<br>(Canada) |
|---------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------|

### ELECTROCHEMISTRY

|                |                                                                                                                                         |                           |
|----------------|-----------------------------------------------------------------------------------------------------------------------------------------|---------------------------|
| October<br>4–5 | “Angewandte Elektrochemie” (Gesellschaft Deutscher Chemiker, Abteilung Fachgruppen, Postfach 90 04 40, D-6000 Frankfurt (Main) 90, FRG) | Frankfurt-Hochst<br>(FRG) |
|----------------|-----------------------------------------------------------------------------------------------------------------------------------------|---------------------------|

### HORMONES & CANCER

|                |                                                                                                                                                                                                                              |                 |
|----------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|
| October<br>4–6 | First Int’l. Congress on Hormones & Cancer (Prof. S. Lacobelli, Laboratorio di Endocrinologia Molecolare, Institute di Clinica, Ostetrica e Ginecologica, Universita Cattolica, Via Pineta Sacchetti, 644-00168 Rome, Italy) | Rome<br>(Italy) |
|----------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|

### WATER POLLUTION CONTROL

|                 |                                                                                                                         |                  |
|-----------------|-------------------------------------------------------------------------------------------------------------------------|------------------|
| October<br>7–12 | Water Pollution Control Federation International Convention (R. A. Canham, 3900 Wisconsin St., Chicago 111, 60606, USA) | Houston<br>(USA) |
|-----------------|-------------------------------------------------------------------------------------------------------------------------|------------------|

### ANALYTICAL CHEM: IN ENERGY TECHNOLOGY

|                 |                                                                                                                                                               |                            |
|-----------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------|
| October<br>9–11 | 23rd ORNL Conference on Analytical Chemistry on Energy Technology (Dr. W. S. Lyon Jr., Oak Ridge National Laboratory, P.O. Box X, Oak Ridge, Tenn. 37830 USA) | Gatlinburg, Tenn.<br>(USA) |
|-----------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------|

### UPDATE COURSE FOR ORGANIC CHEMISTS

|                     |                                                                                                                                                                                                                                              |                 |
|---------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|
| Oct. 14–<br>Nov. 30 | A seven-week refresher course in modern organic chemistry for senior industrial PhD chemists, with emphasis on advances in the last 10 years. (Prof. A. R. Katritzky, School of Chemical Sciences, Univ. of East Anglia, Norwich NR4 7TJ UK) | Norwich<br>(UK) |
|---------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|

### CLINICAL BIOCHEMISTRY

|                  |                                                                                                                                                                                                                |           |
|------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|
| October<br>14–19 | 1st South East Asian and Pacific Congress of Clinical Biochemistry (1st SEAP Congress of Clinical Biochemistry Singapore Professional Centre, 129 B Block 23, Outram Park, Singapore 3, Republic of Singapore) | Singapore |
|------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|

### LABORATORY EQUIPMENT

|                  |                                                                                                                                                                                           |                   |
|------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|
| October<br>17–20 | International Exhibition on Laboratory Technology Analyses, Procedures and Automation in Chemistry (Media Consult GmbH, Conventions and Exhibitions, P.O. Box 404, A-1171, Wien, Austria) | Graz<br>(Austria) |
|------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|

### CHROMATOGRAPHY

|                  |                                                                                                                                               |                       |
|------------------|-----------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|
| October<br>21–24 | 18th ASTM Annual Meeting on the Practice of Chromatography (Dr. T. Bradley, Spectra-Physics, 2905 Stender Way, Santa Clara, Calif. 95051 USA) | Philadelphia<br>(USA) |
|------------------|-----------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|

### AIR POLLUTION

|                  |                                                                                                                                                     |                            |
|------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------|
| October<br>22–25 | Int’l. Conference on Air Pollution (Conference Secretariat S 193, Conference Division, CSIR, P.O. Box 395, Pretoria, Republic of South Africa 0001) | Pretoria<br>(South Africa) |
|------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------|

### RECLAMATION OF CONTAMINATED LAND

|                  |                                                                                                                                                |                    |
|------------------|------------------------------------------------------------------------------------------------------------------------------------------------|--------------------|
| October<br>22–25 | Reclamation of Contaminated Land (Miss J. Bovier, Conference Secretary, Society of Chemical Industry, 14 Belgrave Square, London SW1X 8PS, UK) | Eastbourne<br>(UK) |
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## CONFERENCES 1979

### EXPLOSIVES – SPACE APPLICATIONS

|                  |                                                                                                                                                                                                           |                      |
|------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------|
| October<br>23–35 | Int'l. Conference on Space Applications of Explosives & Pyrotechnics (Centre National D'Etudes Spatiales, Departement des Affaires Universitaires, 18 avenue Edouard-Belin, 31055 Toulouse Cedex, France) | Toulouse<br>(France) |
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### LIQUID CHROMATOGRAPHY

|                  |                                                                                                                           |            |
|------------------|---------------------------------------------------------------------------------------------------------------------------|------------|
| October<br>24–25 | International Liquid Chromatography Symposium (Dr. J. Cazes, Waters Associates, 34 Maple Street, Milford, Mass 01757 USA) | Strasbourg |
|------------------|---------------------------------------------------------------------------------------------------------------------------|------------|

### QUANTUM CHEMISTRY

|                           |                                                                                                                                                                                                                                   |                  |
|---------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------|
| October 29–<br>November 3 | Third International Congress of Quantum Chemistry (Prof. Teijiro Yonezawa, Secretary General, Third International Congress of Quantum Chemistry, c/o Kyoto International Conference Hall, Takara-ike, Sakyo-ku, Kyoto, Japan 606) | Kyoto<br>(Japan) |
|---------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------|

### PROTEINS/MEMBRANES

|            |                                                                                                                           |                |
|------------|---------------------------------------------------------------------------------------------------------------------------|----------------|
| November 8 | Fluorescent probes in proteins and membranes (Dr. G. S. Beddard, Royal Institution, 21 Albermarle Street, London W1X 4BS) | London<br>(UK) |
|------------|---------------------------------------------------------------------------------------------------------------------------|----------------|

### REFERENCE MATERIALS

|                   |                                                                                                                                                                         |                          |
|-------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------|
| November<br>13–16 | Int'l. Symposium on the Production and Use of Reference Materials (Prof. Dr. R. Neider, Bundesanstalt fur Materialprufung, Unter den Eichen 87, D-1000, Berlin 45, FRG) | Berlin<br>(F.R. Germany) |
|-------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------|

### RADIATIONLESS PROCESSES

|                    |                                                                                                                                                                                                      |                  |
|--------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------|
| Nov. 18–<br>Dec. 1 | A six-week course at the Int'l. School of Atomic & Molecular Spectroscopy (Prof. B. Di Bartolo, Dept. of Physics, Boston College, Chestnut Hill, Mass. 02167 USA) Application Closing Date: Sept. 15 | Erice<br>(Italy) |
|--------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------|

### NON-DESTRUCTIVE TESTING

|                   |                                                                                                                     |                          |
|-------------------|---------------------------------------------------------------------------------------------------------------------|--------------------------|
| November<br>18–23 | 9th World Conference on Non-destructive Testing (R. B. Oke, NATA 191 Royal Parade, Parkville, Vic. 3052, Australia) | Melbourne<br>(Australia) |
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### LASER INTERACTION WITH PLASMAS

|                   |                                                                                                                                |                         |
|-------------------|--------------------------------------------------------------------------------------------------------------------------------|-------------------------|
| November<br>19–23 | Laser Interactions & Related Plasma Phenomena (Mr. H. J. Schwartz, Rennsalaer Polytechnic Institute, Troy, New York 12181 USA) | Troy, New York<br>(USA) |
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### HYDROGEN IN METALS

|                   |                                                                                                                                                                           |                         |
|-------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------|
| November<br>26–29 | 2nd Int'l. Symposium on Hydrogen in Metals (JIMIS – 11 Secretariat, Mr. Hirokiti Sasaki, Executive Secretary, Japan Institute of Metals, Aoba Aramaki, Sendai 980, Japan) | Minakami<br>Spa (Japan) |
|-------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------|

### NUCLEAR SAFEGUARDS

|                   |                                                                                                                                                                                       |                           |
|-------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------|
| November<br>26–29 | American Nuclear Society Conference on "Measurement Technology for Safeguards and Materials Control" (T. Canada, Los Alamos Scientific Lab, MS-540, Los Alamos, New Mexico 87544 USA) | Charleston, S.C.<br>(USA) |
|-------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------|

### CHEMISTRY OF EARTH'S INTERIOR

|                  |                                                                                                                                                                                                                                                      |                         |
|------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------|
| December<br>2–15 | Chemistry of the Earth's Interior, General Assembly of Int'l. Association of Volcanology (Dr. P. E. Baker, Int'l. Association of Volcanology and Chemistry of the Earth's Interior, Department of Earth Sciences, The University, Leeds LS2 9JT, UK) | Canberra<br>(Australia) |
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### HYDROCARBON CHEMISTRY

|                   |                                                                                                                                                                                                                                                                                 |                      |
|-------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------|
| December<br>10–11 | International Symposium on New Horizons in Hydrocarbon Chemistry (Prof. L. M. Stephenson, The Institute of Hydrocarbon Chemistry, Science Hall 101, The University of Southern California, Los Angeles, California 90007, USA)<br>Additional information provided in this issue | Los Angeles<br>(USA) |
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### ALTERNATE ENERGY SOURCES

|                   |                                                                                                                                                                                    |                           |
|-------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------|
| December<br>10–12 | 2nd Miami Int'l. Conference on Alternative Energy Sources (Dr. T. N. Veziroglu, Clean Energy Research Institute, Univ. of Miami, P.O. Box 248294, Coral Gables, Florida 33124 USA) | Miami Beach, Fl.<br>(USA) |
|-------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------|

### COORDINATION CHEMISTRY

|                   |                                                                                                                                                                                                                                |                     |
|-------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|
| December<br>10–14 | 20th International Conference on Coordination Chemistry (Prof. D. Banerjee, Convener XX-ICCC, Indian Chemical Society, 92 Acharyya Prafulla Chandra Road, Calcutta 700 009, India)<br>Additional information in previous issue | Calcutta<br>(India) |
|-------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|

CRYSTALLOGRAPHIC COMPUTING

- |                 |                                                                                                                                                                                                                                                         |                      |
|-----------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------|
| January<br>4-14 | Course on Crystallographic Computing, organised by the Int'l. Union of Crystallography in association with the Indian Institute of Science (Prof. K. Venkatesan, Department of Organic Chemistry, Indian Institute of Science, Bangalore 560012, India) | Bangalore<br>(India) |
|-----------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------|

NEW POLYMER CHEMISTRY APPLICATIONS

- |                 |                                                                                                                                                                       |                   |
|-----------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|
| January<br>7-11 | Int'l. Symposium on New Frontiers in Polymer Chemistry and Polymer Applications (Dr. N. Ramanathan, Central Leather Research Institute, Adyar, Madras-600 020, India) | Madras<br>(India) |
|-----------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|

METALLIC CLUSTERS

- |                |                                                                                                                                                       |                    |
|----------------|-------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------|
| January<br>8-9 | Diatomic Metals and Metallic Clusters, Symposium No. 14 (Dr. H. A. Skinner, Dept. of Chemistry, The University of Manchester, Manchester M13 9PL, UK) | Manchester<br>(UK) |
|----------------|-------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------|

INDUSTRIAL WASTE

- |                 |                                                                                                                                                                                                                                            |                       |
|-----------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|
| February<br>6-8 | 3rd International Congress on Industrial Waste Water and Wastes (Mr. B. Goransson, Institutet for Vatten-och Luftvardsforskning, POB 21060, Helsingegatan 43, S-100 31 Stockholm, Sweden)<br>Additional information provided in this issue | Stockholm<br>(Sweden) |
|-----------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|

DEGRADATION OF ORGANIC COATINGS

- |              |                                                                                                                                                                                        |                  |
|--------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------|
| March<br>3-7 | Symposium on Photodegradation, Photo-oxidation and Photo-stabilization of Organic Coatings 179th ACS National Meeting (F. H. Winslow, Bell Laboratories, Murray Hill, N.J. 07974, USA) | Houston<br>(USA) |
|--------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------|

ANALYTICAL SPECTROSCOPY

- |              |                                                                                                                                               |                         |
|--------------|-----------------------------------------------------------------------------------------------------------------------------------------------|-------------------------|
| March<br>3-7 | 31st Pittsburgh Conference on Analytical Spectroscopy (Analytical Chemistry Group, Amer. Chem. Soc., 1155 16th Street N.W., Wash. D.C. 20036) | Cleveland<br>Ohio (USA) |
|--------------|-----------------------------------------------------------------------------------------------------------------------------------------------|-------------------------|

AMERICAN CHEMICAL SOCIETY

- |                |                                                                                                   |                  |
|----------------|---------------------------------------------------------------------------------------------------|------------------|
| March<br>23-28 | ACS - Spring - Meeting (American Chemical Society, 1155 16 Street NW, Washington D.C. 20036, USA) | Houston<br>(USA) |
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CHEMICAL REACTION ENGINEERING

- |                |                                                                                                                                                                                         |                  |
|----------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------|
| March<br>25-27 | 6th International Symposium on Chemical Reaction Engineering (Prof. Jacques Villiermaux, Laboratoire des Sciences du Genie Chimique, CNRS-ENSIC, 1 rue Grandville, 54042-Nancy, France) | Nice<br>(France) |
|----------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------|

PHASE TRANSITIONS IN MOLECULAR SOLIDS

- |                |                                                                               |                |
|----------------|-------------------------------------------------------------------------------|----------------|
| March<br>26-28 | (Faraday Division, UK Chemical Society, Burlington House, London W1V 0BN, UK) | Exeter<br>(UK) |
|----------------|-------------------------------------------------------------------------------|----------------|

POLYMER FLOW PROPERTIES

- |                |                                                                                                                                                                                                           |                      |
|----------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------|
| March<br>26-28 | Int'l. Conference on Practical Rheology in Polymer Processing (Dr. D. E. Marshall, Institute of Polymer Technology, University of Technology, University of Technology, Loughborough, Leics LE11 3TU, UK) | Loughborough<br>(UK) |
|----------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------|

LIQUIFIED NATURAL GAS

- |               |                                                                                                                             |                  |
|---------------|-----------------------------------------------------------------------------------------------------------------------------|------------------|
| April<br>6-11 | Int'l. Conference on Liquefied Natural Gas (Dr. David Roe, British Gas Corporation, 59 Bryanston Street, London W1A 2AZ UK) | Kyoto<br>(Japan) |
|---------------|-----------------------------------------------------------------------------------------------------------------------------|------------------|

PLASMA PHYSICS

- |               |                                                                                                                                |                            |
|---------------|--------------------------------------------------------------------------------------------------------------------------------|----------------------------|
| April<br>7-11 | International Conference of Plasma Physics (K. Nishikawa, Institute for Fusion Theory, Hiroshima University, Hiroshima, Japan) | Tokyo or Nagoyo<br>(Japan) |
|---------------|--------------------------------------------------------------------------------------------------------------------------------|----------------------------|

BIOMATERIALS

- |               |                                                                                                                                                     |                     |
|---------------|-----------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|
| April<br>8-12 | 2nd World Congress on Biomaterials (Dr. J. L. Leray, Pavillon Ollier Hopital Cochin, 27 rue du Faubourg ST-Jacques, F-75674 Paris Cedex 14, France) | Vienna<br>(Austria) |
|---------------|-----------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|

SURFACE COATING & SURFACE TREATMENT

- |               |                                                                                  |                |
|---------------|----------------------------------------------------------------------------------|----------------|
| April<br>9-11 | (Industrial Division, UK Chemical Society, Burlington House, London W1V 0BN, UK) | Durham<br>(UK) |
|---------------|----------------------------------------------------------------------------------|----------------|

CHEMICAL ENGINEERING

- |                |                                                                                                                                                                                |                         |
|----------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------|
| April<br>14-16 | 5th International Scandinavian Congress of Chemical Engineering - European Federation of Chemical Engineering (Bella Center A/S, Center Boulevard, 2300 Copenhagen S, Denmark) | Copenhagen<br>(Denmark) |
|----------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------|



## CONFERENCES 1980

### CHEM. ENGINEERING/SCANDINAVIA

|                |                                                                                                                               |                         |
|----------------|-------------------------------------------------------------------------------------------------------------------------------|-------------------------|
| April<br>14-16 | 5th Int'l. Scandinavian Congress of Chemical Engineering (Bella-Centret A/S, Center Boulevard, DK-2300 Copenhagen S, Denmark) | Copenhagen<br>(Denmark) |
|----------------|-------------------------------------------------------------------------------------------------------------------------------|-------------------------|

### UK CHEMICAL SOCIETY CONGRESS

|                |                                                                                       |                |
|----------------|---------------------------------------------------------------------------------------|----------------|
| April<br>15-17 | Annual Chemical Congress (The Chemical Society, Burlington House, London W1V 0BN, UK) | Durham<br>(UK) |
|----------------|---------------------------------------------------------------------------------------|----------------|

### SOLID SEPARATION

|                |                                                                                                                                                                                         |                     |
|----------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|
| April<br>16-18 | Int'l. Conference on Solids Separation Processes (Int'l. Conference on Solids Processing, The Institution of Chemical Engineers, BeMRA, Tramway House, Dartry Road, Ireland - Dublin 6) | Dublin<br>(Ireland) |
|----------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|

### PHOSPHORUS COMPOUNDS

|                |                                                                                                            |                 |
|----------------|------------------------------------------------------------------------------------------------------------|-----------------|
| April<br>21-25 | Second International Congress on Phosphorus Compounds (IMPHOS-8, rue de Penthièvre, F-75008 Paris, France) | Boston<br>(USA) |
|----------------|------------------------------------------------------------------------------------------------------------|-----------------|

### ATMOSPHERIC POLLUTION

|            |                                                                                                                                                        |                   |
|------------|--------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|
| May<br>5-7 | 14th Int'l. Symposium on Atmospheric Pollution (M. Benarie, Institut National de recherche Chimique Appliquee, B.P. No. 1, 91710 Vert-le-Petit France) | Paris<br>(France) |
|------------|--------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|

### NON-METALS IN METALS

|              |                                                                                                                                                   |                 |
|--------------|---------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|
| May<br>10-13 | Non-Metals in Metals (Gesellschaft Deutscher Chemiker, Abt. Fachgruppen, Postfach 900440 D-6000 Frankfurt (Main) 90, Federal Republic of Germany) | Berlin<br>(FRG) |
|--------------|---------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|

### GENERAL MEETING ANZAAS

|              |                                                                                                                                                        |                         |
|--------------|--------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------|
| May<br>12-16 | 50th Congress of the Australian and New Zealand Association for Advancement of Science (Dr. J. R. Best, 141 Rundle Mall, Adelaide, SA 5000, Australia) | Adelaide<br>(Australia) |
|--------------|--------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------|

### ION EXCHANGE

|              |                                                                                                                                            |                           |
|--------------|--------------------------------------------------------------------------------------------------------------------------------------------|---------------------------|
| May<br>27-30 | 4th Symposium on Ion Exchange (Prof. J. Inczedy, Organizing Committee, 4th Symposium on Ion Exchange, P.O.B. 28, Veszprem, Hungary H-8201) | Balaton Lake<br>(Hungary) |
|--------------|--------------------------------------------------------------------------------------------------------------------------------------------|---------------------------|

### ANALYSIS OF POLLUTANTS

|              |                                                                                                                                                                                                     |                   |
|--------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|
| May<br>28-30 | 10th Annual Symposium on the Analytical Chemistry of Pollutants (Gesellschaft Deutscher Chemiker, Abteilung Fachgruppen, Postfach 90 04 40, D-6000 Frankfurt (Main) 90 Federal Republic of Germany) | Dortmund<br>(FRG) |
|--------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|

### MEDICAL CHEMISTRY

|      |                                                                                                                                      |                              |
|------|--------------------------------------------------------------------------------------------------------------------------------------|------------------------------|
| June | 17th National Medical Chemistry Symposium (Division of Medical Chemistry, Amer. Chem. Soc., 1155 16th street N.W., Wash. D.C. 20036) | Rensselaer<br>New York (USA) |
|------|--------------------------------------------------------------------------------------------------------------------------------------|------------------------------|

### POLYVINYL CHLORIDE

|      |                                                                                                                                               |                         |
|------|-----------------------------------------------------------------------------------------------------------------------------------------------|-------------------------|
| June | 3rd International Symposium on Polyvinyl Chloride (Dr. E. A. Collins, Diamond Shamrock Corporation, PO Box 348, Painesville, Ohio 44077, USA) | Cleveland/Ohio<br>(USA) |
|------|-----------------------------------------------------------------------------------------------------------------------------------------------|-------------------------|

### SOLUTE-SOLVENT INTERACTIONS

|             |                                                                                                                                                                                                                                                                                 |                     |
|-------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|
| June<br>2-6 | 5th International Symposium on Solute-Solute-Solvent Interactions (Prof. I. Bertini, Faculta di Farmacia, Istituto di Chimica Generale e Inorganica, Università degli Studi di Firenze, Via Gino Capponi 7, I-50121 Firenze, Italy)<br>Additional information in previous issue | Florence<br>(Italy) |
|-------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|

### ZEOLITES

|             |                                                                                                                                                           |                   |
|-------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|
| June<br>2-6 | 5th International Conference on Zeolites (Prof. R. Sersale, Istituto di Chimica Applicata, Università di Napoli, Piazzale Tecchio, I-80125 Napoli, Italy) | Naples<br>(Italy) |
|-------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|

### PARTICLE TECHNOLOGY IN CHEMICAL ENGINEERING

|             |                                                                                                                                                                                          |                            |
|-------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------|
| June<br>3-5 | Symposium on Particle Technology - European Federation of Chemical Engineering (Ir. M. A. G. Vorstman, TH Eindhoven, afd. VAK Gr. Fys. Technologie, Postbus 513, Eindhoven, Netherlands) | Amsterdam<br>(Netherlands) |
|-------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------|

### TEXTILE DYES

|             |                                                                                                                   |                      |
|-------------|-------------------------------------------------------------------------------------------------------------------|----------------------|
| June<br>5-6 | HV der Vereins der Textilchemiker (VTCC, Rohrbacher Strasse 76, D-6900 Heidelberg 1, Federal Republic of Germany) | Baden-Baden<br>(FRG) |
|-------------|-------------------------------------------------------------------------------------------------------------------|----------------------|

## CONFERENCES 1980

### ORGANIC SYNTHESIS

|               |                                                                                                                                                                               |                             |
|---------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------|
| June<br>15-20 | 3rd IUPAC Symposium on Organic Synthesis (Prof. B. M. Trost, Department of Chemistry, University of Wisconsin—Madison, 1101 University Avenue, Madison, Wisconsin 53706, USA) | Madison, Wisconsin<br>(USA) |
|---------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------|

### URETHANE CHEMISTRY

|              |                                                                                                             |                        |
|--------------|-------------------------------------------------------------------------------------------------------------|------------------------|
| June<br>9-13 | International Urethane Conference (Dr. Franzkarl Brochhagen, Bayer AG, PU-A, 5090 Leverkusen, F.R. Germany) | Strasbourg<br>(France) |
|--------------|-------------------------------------------------------------------------------------------------------------|------------------------|

### CHEMICAL EDUCATION

|               |                                                                                                                              |                              |
|---------------|------------------------------------------------------------------------------------------------------------------------------|------------------------------|
| June<br>22-26 | 6th Biennial Conference on Chemical Education (L. Fine, Dept. of Chemistry, Housatonic College, Bridgeport, Conn. 06608 USA) | Rochester, New York<br>(USA) |
|---------------|------------------------------------------------------------------------------------------------------------------------------|------------------------------|

### WATER POLLUTION RESEARCH

|               |                                                                                                                                                             |                     |
|---------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|
| June<br>23-27 | 10th Int'l. Conference on Water Pollution Research (Int. Assn. on Water Pollution Research (IAWPR) Chichester House, 278 High Holborn, London WC1V 7HF, UK) | Toronto<br>(Canada) |
|---------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|

### ORIGIN OF LIFE

|               |                                                                                                                                    |                       |
|---------------|------------------------------------------------------------------------------------------------------------------------------------|-----------------------|
| June<br>23-28 | 6th Int'l. Conference on the Origin of Life (Dr. M. Paecht-Horowitz, Polymer Dept., Weizman Institute of Science, Rehovot, Israel) | Jerusalem<br>(Israel) |
|---------------|------------------------------------------------------------------------------------------------------------------------------------|-----------------------|

### HYDROGEN ENERGY

|                    |                                                                                                                                                                                                       |                  |
|--------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------|
| June 27-<br>July 1 | 3rd World Hydrogen Energy Conference (Secretariat, 3rd World Hydrogen Energy Conference, Japan Convention Services Inc, Nippon Press Center Bldg, 2-2-1 Uchisaiwai-cho, Chiyoda-ku, Tokyo 100, Japan) | Tokyo<br>(Japan) |
|--------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------|

### B-LACTAM ANTIBIOTICS

|                    |                                                                                  |                   |
|--------------------|----------------------------------------------------------------------------------|-------------------|
| June 30-<br>July 3 | (Industrial Division, UK Chemical Society, Burlington House, London W1V 0BN, UK) | Cambridge<br>(UK) |
|--------------------|----------------------------------------------------------------------------------|-------------------|

### CHROMATOGRAPHY

|                   |                                                                                                                                                                              |                    |
|-------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------|
| June 30<br>July 4 | 13th Int'l. Symposium on Chromatography (Prof. G. Guichon, Ecole Polytechnique, Laboratoire de Chimie, Analytique Physique, Rte. de Saclay, F-91128 Palaiseau Cedex, France) | Cannes<br>(France) |
|-------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------|

### CATALYSIS

|                   |                                                                                                                                                                                                               |                  |
|-------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------|
| June 30<br>July 4 | 7th International Congress on Catalysis (Prof. I. Yasumori, Department of Chemistry, Tokyo Institute of Technology, 2-12-1 Ookayama, Meguro-ku, Tokyo 152, Japan)<br>Additional information in previous issue | Tokyo<br>(Japan) |
|-------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------|

### DRYING

|          |                                                                                                                                                                            |                      |
|----------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------|
| July 6-9 | 2nd Int'l. Symposium on Drying (Dr. A. S. Mujumadar, Program Chairman, Dept. of Chemical Engineering, McGill University, 3480 University Street, Montreal, Quebec, Canada) | Montreal<br>(Canada) |
|----------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------|

### THERMAL ANALYSIS

|              |                                                                                                                              |                   |
|--------------|------------------------------------------------------------------------------------------------------------------------------|-------------------|
| July<br>6-12 | 6th Int'l. Conference on Thermal Analysis (ICTA '80) (6th ICTA '80, Postfach 1120, D-8672 Selb, Federal Republic of Germany) | Bayreuth<br>(FRG) |
|--------------|------------------------------------------------------------------------------------------------------------------------------|-------------------|

### CARBOHYDRATE CHEMISTRY

|              |                                                                                                                                                                                                                                      |                       |
|--------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|
| July<br>7-11 | 10th International Symposium on Carbohydrate Chemistry (Prof. S. J. Angyal, School of Chemistry, University of New South Wales, P.O. Box 1, Kensington, New South Wales 2033, Australia)<br>Additional information in previous issue | Sydney<br>(Australia) |
|--------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|

### PHOTOBIOLOGY

|               |                                                                                                                                                                                                          |                        |
|---------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------|
| July<br>20-25 | 8th International Congress on Photobiology (M. Charlier, Congres International de Photobiologie, Centre de Biophysique Moleculaire, 1A avenue de la Recherche Scientifique, 45045 Orleans Cedex, France) | Strasbourg<br>(France) |
|---------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------|

### ANALYTICAL CHEMISTRY

|               |                                                                                                                                                             |                   |
|---------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|
| July<br>20-26 | SAC 80: International Conference on Analytical Chemistry (Dr. J. D. R. Thomas, Department of Chemistry, UWIST, King Edward VII Avenue, Cardiff CF1 3NU, UK) | Lancaster<br>(UK) |
|---------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|

### FERMENTATION

|               |                                                                                                                                                                                                               |                             |
|---------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------|
| July<br>20-25 | 6th International Fermentation Symposium (Prof. J. E. Zajic, Faculty of Engineering Science, University of Western Ontario. London, Ontario, Canada N6A 5B9)<br>Additional information provided in this issue | London, Ontario<br>(Canada) |
|---------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------|



## CONFERENCES 1980

### GERMANIUM, TIN AND LEAD

|               |                                                                                                                                                                                                     |                   |
|---------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|
| July<br>21-25 | 3rd International Conference on the Organometallic and Coordination Chemistry of Germanium, Tin and Lead (Dr. J. F. Gibson, The Chemical Society, Burlington House, Piccadilly, London W1V 0BN, UK) | Dortmund<br>(FRG) |
|---------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|

### CHEMISTRY IN AFRICAN DEVELOPMENT

|                    |                                                                                                                                                                                                                           |                    |
|--------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------|
| July 28-<br>Aug. 1 | The first International Chemistry Conference in Africa, entitled "Chemistry in the Development and Environment of Africa" (Dr. S. Wandiga, Chairman Dept. of Chemistry, Univ. of Nairobi, P.O. Box 30197, Nairobi, Kenya) | Nairobi<br>(Kenya) |
|--------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------|

### PHOTOCHEMICAL ENERGY STORAGE

|                   |                                                                                                                                                                            |                   |
|-------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|
| July or<br>August | 3rd Int'l. Conference on Photochemical Conversion and Storage of Solar Energy (Dr. J. S. Connolly, Solar Energy Research Institute, 1536 Cole Boul., Golden, CO 80401 USA) | Colorado<br>(USA) |
|-------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|

### PHOTOSYNTHESIS

|        |                                                                                                                                                         |                   |
|--------|---------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|
| Summer | 5th Int'l. Congress of Photosynthesis (Dr. C. Akoyunonoglu, IPC, Dept. of Biology Nuclear Research Center, Demokrites, Aghia Parasheri, Athens, Greece) | Corfu<br>(Greece) |
|--------|---------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|

### OZONE

|        |                                                                                                                                                                                                |                            |
|--------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------|
| August | Symposium sponsored by International Association of Meteorology and Atmospheric Physics, WMO and COSPAR (Mr. S. Ruttenberg, Secretary IAMAP NCAR, P.O. Box 3000, Boulder, Colorado 80307, USA) | Boulder, Colorado<br>(USA) |
|--------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------|

### PHYSICAL ORGANIC CHEMISTRY

|                 |                                                                                                                                                                          |                                 |
|-----------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------|
| August<br>17-22 | 5th IUPAC Conference on Physical Organic Chemistry (Prof. J. F. Bunnett, Division of Natural Sciences - II, University of California, Santa Cruz, California 95064, USA) | Santa Cruz, California<br>(USA) |
|-----------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------|

### ENERGY CONVERSION

|                 |                                                                                                                                   |                              |
|-----------------|-----------------------------------------------------------------------------------------------------------------------------------|------------------------------|
| August<br>18-22 | 15th Intersociety Energy Conversion Engineering Conference (S. Silverman, 19630 Marine View Drive S.W., Seattle, Washington, USA) | Seattle, Washington<br>(USA) |
|-----------------|-----------------------------------------------------------------------------------------------------------------------------------|------------------------------|

### TRANSITION METALS

|                 |                                                                                                                                         |               |
|-----------------|-----------------------------------------------------------------------------------------------------------------------------------------|---------------|
| August<br>18-22 | Int'l. Conference on the Physics of Transition Metals (Meetings Officer, The Institute of Physics, 47 Belgrave Square, London SW1X 8QX) | Leeds<br>(UK) |
|-----------------|-----------------------------------------------------------------------------------------------------------------------------------------|---------------|

### BIOCHEMISTRY

|                 |                                                                                                                                  |                       |
|-----------------|----------------------------------------------------------------------------------------------------------------------------------|-----------------------|
| August<br>24-29 | 13th Meeting of the Federation of European Biochemical Societies (Prof. N. Sharon, Weizman Institut of Science, Rehovot, Israel) | Jerusalem<br>(Israel) |
|-----------------|----------------------------------------------------------------------------------------------------------------------------------|-----------------------|

### GENERAL MEETING, NORTH AMERICA

|                 |                                                                                                                                                    |                        |
|-----------------|----------------------------------------------------------------------------------------------------------------------------------------------------|------------------------|
| August<br>24-29 | 2nd Chemical Congress of the North American Continent (A. T. Winstead, American Chemical Society, 1155 16th Street NW, Washington D.C. 20036, USA) | San Francisco<br>(USA) |
|-----------------|----------------------------------------------------------------------------------------------------------------------------------------------------|------------------------|

### THERMODYNAMICS

|                 |                                                                                                                                                                                                                                             |                    |
|-----------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------|
| August<br>26-29 | 6th International Conference on Thermodynamics (Prof. Dr. Margit Ratzsch, Technische Hochschule "Carl Schorlemmer", Leuna-M Merseberg, 6th Int'l. Conf. on Thermodynamics, DDR-42 Merseburg 6, Geusaer Strasse, German Democratic Republic) | Merseburg<br>(GDR) |
|-----------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------|

### REACTIVITY OF SOLIDS

|                  |                                                                                                                                                                                         |                    |
|------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------|
| September<br>1-6 | 9th Int'l. Symposium on the Reactivity of Solids (Dr. J. Nowotny, Institute of Catalysis and Surface Chemistry, Polish Academy of Sciences, ul. Niezapominajek, 30-239, Krakow, Poland) | Cracow<br>(Poland) |
|------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------|

### COMPUTERS IN CHEMICAL ENGINEERING

|                  |                                                                                                                                                                                                                                        |                    |
|------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------|
| September<br>2-5 | Chemplant '80 - Symposium of the Working Party on Routine Calculations and Use of Computers in Chemical Engineering - European Federation of Chemical Engineering (Hungarian Chemical Society, Anker Kőz 1, 1061 Budapest VI, Hungary) | Heviz<br>(Hungary) |
|------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------|

## CONFERENCES 1980

### MEDICINAL CHEMISTRY

|                  |                                                                                                                                       |                   |
|------------------|---------------------------------------------------------------------------------------------------------------------------------------|-------------------|
| September<br>2-5 | 7th Int'l. Symposium on Medicinal Chemistry (7th Int'l. Symposium on Med. Chemistry, 142-144 Oxford Road, Cowley, Oxford, OX4 2DZ UK) | Madrid<br>(Spain) |
|------------------|---------------------------------------------------------------------------------------------------------------------------------------|-------------------|

### MICROBIAL ADHESION TO SURFACES

|                  |                                                                                                                                                                                       |                 |
|------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|
| September<br>3-5 | Microbial Adhesion to Surfaces, an interdisciplinary meeting (Dr. P. R. Rutter, c/o the Conference Secretariat, Society of Chemical Industry, 14 Belgrave Square, London SW1X 8PS UK) | Reading<br>(UK) |
|------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|

### SOLVENT EXTRACTION

|                   |                                                                                                                                         |                    |
|-------------------|-----------------------------------------------------------------------------------------------------------------------------------------|--------------------|
| September<br>6-12 | Int'l. Solvent Extraction Conference (Secretary ISEC '80, Dept. of Chemistry, University of Liege, Sart Tilman, B-4000, Liege, Belgium) | Liege<br>(Belgium) |
|-------------------|-----------------------------------------------------------------------------------------------------------------------------------------|--------------------|

### ANALYTICAL CHEM./SPECTROSCOPY

|                   |                                                                                                                                                                        |                           |
|-------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------|
| September<br>7-12 | 7th Annual Meeting of the Federation of Analytical Chemistry and Spectroscopy Societies (J. A. Williamson, DuPont Co., Instrument Products Div., Wilmington, Del. USA) | Philadelphia, PA<br>(USA) |
|-------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------|

### MACROMOLECULES

|                   |                                                                                                                                                 |                     |
|-------------------|-------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|
| September<br>7-13 | International Symposium on Macromolecules (Prof. F. Ciardelli, Istituto Chimica Organica Industriale, Via Risorgimento 35, I-56100 Pisa, Italy) | Florence<br>(Italy) |
|-------------------|-------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|

### COAL AS A CHEMICAL FEEDSTOCK

|                   |                                                                                                                                                                                                   |                   |
|-------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|
| September<br>7-11 | Int'l. Conference on coal as a feedstock for the Chemical Industry (Dr. E. Rothwell, Dept. of Chemical Engineering and Fuel Technology, University of Sheffield, Mappin Street, Sheffield S1 3JD) | Sheffield<br>(UK) |
|-------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|

### PHOTOELECTROCHEMISTRY

|                   |                                                                                                                                                   |                |
|-------------------|---------------------------------------------------------------------------------------------------------------------------------------------------|----------------|
| September<br>8-10 | Photoelectrochemistry (Faraday Discussion No. 70) (Prof. W. J. Albery, Dept. of Chemistry, Imperial College, South Kensington, London SW7 2AY UK) | Oxford<br>(UK) |
|-------------------|---------------------------------------------------------------------------------------------------------------------------------------------------|----------------|

### ENERGY

|                   |                                                                                                                                                         |                           |
|-------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------|
| September<br>8-12 | 11th World Energy Conference (Dr. E. Ruttley, WEC, Intern. Executive Council, c/o British National Committee, 34 St. James Street, London SW1A 1HD, UK) | Munchen<br>(F.R. Germany) |
|-------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------|

### INDUSTRIAL SAFETY

|                    |                                                                                                                                                                                                                              |                        |
|--------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------|
| September<br>15-19 | 3rd Int'l. Symposium on Loss Prevention and Safety Promotion in the Process Industries (3rd Int'l. Symposium on Loss Prevention and Safety Promotion in Process Industries, 1980, Postfach 141, CH 4007, Basle, Switzerland) | Basle<br>(Switzerland) |
|--------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------|

### SAFETY IN PROCESS INDUSTRIES

|                    |                                                                                                                                                                                                                                                                          |                        |
|--------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------|
| September<br>15-19 | 3rd International Symposium on Loss Prevention and Safety Promotion in the Process Industries - European Federation of Chemical Engineering (3rd Int'l. Symp. on Loss Prevention and Safety Promotion in the Process Industries, P.O. Box 1 41, 4007 Basle, Switzerland) | Basle<br>(Switzerland) |
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### FLUORINE CHEMISTRY

|                    |                                                                                                                                                       |                  |
|--------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------|------------------|
| September<br>15-19 | 7th European Symposium on Fluorine Chemistry (Prof. G. P. Gambaretto, Istituto di Chimica Industriale della Facolta di Marzola 9, 35100 Padua, Italy) | Padua<br>(Italy) |
|--------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------|------------------|

### POLYMER NETWORKS

|                    |                                                                                                                                                                                                                 |                         |
|--------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------|
| September<br>15-20 | 7th Discussion Conference on Polymer Networks (Dr. P. Cefelin, PMM Secretariat, Institute of Macromolecular Chemistry, 1888 Petriny, Prague 6, Czechoslovakia)<br>Additional information provided in this issue | Karlovy Vary<br>(Czech) |
|--------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------|

### NON-AQUEOUS COLLOIDAL DISPERSIONS

|                    |                                                                              |                   |
|--------------------|------------------------------------------------------------------------------|-------------------|
| September<br>16-18 | (Faraday Division, UK Chemical Society, Burlington House London W1V 0BN, UK) | Edinburgh<br>(UK) |
|--------------------|------------------------------------------------------------------------------|-------------------|

### CRYSTAL DEFECTS

|                    |                                                                                                                                                                                           |                    |
|--------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------|
| September<br>17-21 | 3rd Europhysics topical conference on Lattice Defects in Ionic Crystals (The Secretary, Europhysics Topical Conference, Physics Laboratory, The University, Canterbury, Kent CT2 7NR, UK) | Canterbury<br>(UK) |
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## CONFERENCES 1980/81

### COSMETIC RESEARCH

|                    |                                                                                                                                        |                   |
|--------------------|----------------------------------------------------------------------------------------------------------------------------------------|-------------------|
| September<br>22-25 | 11th International Congress on Cosmetic Research and Technology<br>(Conventions Service Italy, Piazza Mignarelli 4, 00187 Rome, Italy) | Venice<br>(Italy) |
|--------------------|----------------------------------------------------------------------------------------------------------------------------------------|-------------------|

### SOLID SURFACES

|                    |                                                                                                                                                                      |                    |
|--------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------|
| September<br>22-26 | 8th Int'l. Vacuum Congress/4th Int'l. Conference on Solid Surfaces<br>(1980 Steering Committee, Societe Fracaise du Vide, 19 Rue de Renard,<br>75004, Paris, France) | Cannes<br>(France) |
|--------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------|

### POLYMERIZATION OF HETEROCYCLES

|                    |                                                                                                                                                                                                                                                       |                          |
|--------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------|
| September<br>22-26 | 21st Prague Microsymposium on Ring-Opening Polymerization of<br>Heterocycles (Dr. P. Cefelin, PMM Secretariat, Institute of Macro-<br>molecular Chemistry, 1888 Petriny, Prague 6, Czechoslovakia)<br>Additional information provided in this issue ) | Karlovy Vary<br>(Czech.) |
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### WATER POLLUTION CONTROL

|                            |                                                                                                                                          |                              |
|----------------------------|------------------------------------------------------------------------------------------------------------------------------------------|------------------------------|
| September 28-<br>October 3 | Water Pollution Control Federation International Convention (R. A.<br>Canham, 3900 Wisconsin Avenue, NW., Washington D.C. 20016,<br>USA) | Atlantic City, N.J.<br>(USA) |
|----------------------------|------------------------------------------------------------------------------------------------------------------------------------------|------------------------------|

### MODERN RADIOCHEMICAL PRACTICE

|                            |                                                                                     |              |
|----------------------------|-------------------------------------------------------------------------------------|--------------|
| September 29-<br>October 3 | (Analytical Division, UK Chemical Society, Burlington House,<br>London W1V 0BN, UK) | York<br>(UK) |
|----------------------------|-------------------------------------------------------------------------------------|--------------|

### CATALYST DEACTIVATION

|                  |                                                                                                                                                                                                                                                                                       |                      |
|------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------|
| October<br>13-15 | International Symposium on Catalyst Deactivation: Poisoning, Coke<br>formation, Solid state chemical transformations (Prof. B. Delmon,<br>Universite Catholique de Louvain, Group de Physico-Chemie Minerale<br>et de Catalyse, Place Croix du Sud 1, 1348 Louvain-La-Neuve, Belgium) | Antwerp<br>(Belgium) |
|------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------|

### SCIENTIFIC INFORMATION TRANSFER

|                  |                                                                                                                                                                |                            |
|------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------|
| October<br>13-17 | 2nd International Conference of Scientific Editors (Helena Tombal,<br>Elsevier Scientific Publishing Co., P.O. Box 330, 1000 AH Amsterdam,<br>The Netherlands) | Amsterdam<br>(Netherlands) |
|------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------|

## 1981

### UK CHEMICAL SOC. CONGRESS

|              |                                                                                              |                   |
|--------------|----------------------------------------------------------------------------------------------|-------------------|
| April<br>7-9 | Chemical Society Annual Congress (Chemical Society, Burlington<br>House, London W1V 0BN, UK) | Guildford<br>(UK) |
|--------------|----------------------------------------------------------------------------------------------|-------------------|

### SCIENCE/PACIFIC REGION

|     |                                                                                                                                                     |                         |
|-----|-----------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------|
| May | General Meeting of the Australian and New Zealand Association for<br>the Advancement of Science (ANZAAS, 10 Martin Place, Sydney 2000<br>Australia) | Brisbane<br>(Australia) |
|-----|-----------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------|

### NMR

|               |                                                                                                              |                |
|---------------|--------------------------------------------------------------------------------------------------------------|----------------|
| July<br>12-17 | 5th International Meeting on NMR Spectroscopy (UK Chemical<br>Society, Burlington House, London W1V 0BN, UK) | Exeter<br>(UK) |
|---------------|--------------------------------------------------------------------------------------------------------------|----------------|

### PLATINIUM GROUP METALS

|               |                                                                                                                                                       |                 |
|---------------|-------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|
| July<br>19-24 | International Conference on the Chemistry of Platinum Group Metals<br>(Dr. P. L. Goggin, School of Chemistry, The University, Bristol BS8 1TS,<br>UK) | Bristol<br>(UK) |
|---------------|-------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|

### ORGANIC SYNTHESIS

|               |                                                                                                                             |                |
|---------------|-----------------------------------------------------------------------------------------------------------------------------|----------------|
| July<br>20-23 | 7th International Symposia on Synthesis in Organic Chemistry (UK<br>Chemical Society, Burlington House, London W1V 0BN, UK) | Oxford<br>(UK) |
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### CRYSTALLOGRAPHY

|                 |                                                                                                                                                           |                    |
|-----------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------|
| August<br>15-25 | 12th General Assembly and Int'l. Congress of Crystallography (Dr.<br>J. N. King, Int'l. Union of Crystallography, 5 Abbey Square, Chester<br>CHI 2HU, UK) | Ottawa<br>(Canada) |
|-----------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------|

### AMERICAN CHEMICAL SOCIETY

|                 |                                                                                                    |                        |
|-----------------|----------------------------------------------------------------------------------------------------|------------------------|
| August<br>23-28 | ACS-FALL-MEETING (American Chemical Society, 1155 16th Street<br>N.W., Washington D.C. 20036, USA) | New York City<br>(USA) |
|-----------------|----------------------------------------------------------------------------------------------------|------------------------|

## CONFERENCES 1981

### EUROANALYSIS

|                 |                                                                                                                                              |                       |
|-----------------|----------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|
| August<br>23-28 | 4th FECS Conference Euroanalysis (Prof. Lauri Niinisto, Department of Chemistry, Helsinki University of Technology, 02150 Espoo 15, Finland) | Helsinki<br>(Finland) |
|-----------------|----------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|

### SOLAR ENERGY

|                 |                                                                                                                              |                  |
|-----------------|------------------------------------------------------------------------------------------------------------------------------|------------------|
| August<br>24-28 | Int'l. Solar Energy Congress (Prof. David Hall, University of London, Kings College, 68 Half Moon Lane, London SE24 9JF, UK) | Brighton<br>(UK) |
|-----------------|------------------------------------------------------------------------------------------------------------------------------|------------------|

### NONBENZENOID AROMATIC COMPOUNDS

|                           |                                                                                                                                                                                    |                       |
|---------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|
| August 30-<br>September 4 | 4th International Symposium on Chemistry of Nonbenzenoid Aromatic Compounds (Prof. I. Agranat, Department of Organic Chemistry, Hebrew University of Jerusalem, Jerusalem, Israel) | Jerusalem<br>(Israel) |
|---------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|

### HETEROGENOUS CATALYSIS

|                    |                                                                                                                                                                 |                    |
|--------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------|
| September<br>14-16 | Selectivity in Heterogeneous Catalysis (General Discussion No. 72) (Prof. F. S. Stone, Department of Chemistry, University of Bath, Bath, Somerset BA2 7AY, UK) | Nottingham<br>(UK) |
|--------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------|

### WATER POLLUTION CONTROL

|                 |                                                                                                                           |                            |
|-----------------|---------------------------------------------------------------------------------------------------------------------------|----------------------------|
| October<br>4-10 | Water Pollution Control Federation Int'l. Convention (R. A. Canham, 3900 Wisconsin Avenue NW, Washington D.C. 20016, USA) | Detroit, Michigan<br>(USA) |
|-----------------|---------------------------------------------------------------------------------------------------------------------------|----------------------------|

## Additional Information

## Upcoming IUPAC Conferences

### *International Symposium on Phosphorus Chemistry directed towards Biology*

*25-28 September 1979  
Burzenin, Poland*

Recent progress in biological applications of phosphorus chemistry will be the topic of this symposium. It will serve as an exchange of information between organic chemists involved in the following fields:

- (1) Phosphorylation
- (2) Synthesis of nucleic acid components
- (3) Synthesis of organophosphorus biomimetics
- (4) Organophosphorus intermediates in the synthesis of biologically important compounds.

The scientific program will consist of 23 plenary lectures, each of about 30 minutes duration and a five-minute discussion period. In addition, there will be three one-hour poster sessions.

Abstracts of all plenary lectures and contributed papers from poster sessions will be distributed to participants upon registration.

The official language of the symposium is English.

Burzenin, the location of the symposium, is a small

village situated on the Warta River 60 km southwest of Lodz. Participants will be accommodated in a new hotel a short walk from the lecture hall. A symposium guide will meet arriving participants at Warsaw International Airport on the 23rd and 24th September. Transportation to Burzenin by motor coach will be arranged from a rallying point in Warsaw (Staszic Palace, Nowy Swiat 72) on Sept. 24.

A sightseeing tour will be provided for all participants of the symposium on Thursday, Sept. 27th. A tourist and social program will be arranged during the conference for those accompanying participants. After completion of the conference, participants will be returned by motor coach to Warsaw.

All enquiries concerning the conference should be addressed to Dr. A. Okruszek, Polish Academy of Sciences, Centre of Molecular and Macromolecular Studies, Boczna 5, 90-362 Lodz, Poland.



# ***New Horizons in Hydrocarbon Chemistry***

***10-11 December 1979***

***Los Angeles, Calif. USA***

The Symposium "New Horizons in Hydrocarbon Chemistry" will focus on problems in hydrocarbon chemistry, drawing attention to fundamental aspects of new hydrocarbon reactions, sources and transformations. Plenary speakers at the symposium will be:

M. Boudart (Stanford University)

J. Sinfeld (Exxon Corporation)

K. Tanabe (Hokkaido University, Japan)

J. M. Lehn (University Louis Pasteur, France)

G. Wilke (Max Plank Institut, FRG)

P. Pino (Swiss Federal Inst. of Tech.)

J. Beauchamp (Calif. Institute of Tech.)

P. Schleyer (Universitat Erlangen-Nurnberg)

Each session of plenary lectures will also have three invited panelists to discuss some of the points brought up by the speakers.

The symposium will be held at the Davidson Conference Center of the University of Southern California (in Los Angeles). It is sponsored jointly by IUPAC and the USC Hydrocarbon Research Institute.

A conference fee of US \$75 will be charged.

Further information can be obtained by writing to Ms. Marsha Elliot, Hydrocarbon Research Institute, University of Southern California, SCI 101 University Park, Los Angeles, California 90007, USA.

## ***3rd International Congress on Industrial Wastewater & Wastes***

***6-8 February 1980***

***Stockholm, Sweden***

Treatment, recirculation, reuse and disposal of industrial water and wastes were subjects of the two previous congresses on Industrial Wastewater and Wastes. This present meeting is intended to review recent developments and trends within these areas. It also will discuss effluent criteria relating to the effects of pollution. The conference should be of greatest interest to industrial representatives and other persons concerned with industrial environmental problems.

The program will consist of main lectures by prominent experts, and discussion papers. There will be four main sessions:

- (1) Effluent criteria for pollutants (identification, significance, and the fate of specific pollutants).
- (2) Recent developments and future trends in industrial waste water technology.
- (3) Treatment and disposal of liquid and solid industrial wastes.
- (4) Low waste technology for chemical industries, metal processing, pulp and paper industries, food and textile industries.

The official language of the conference will be English. No simultaneous translation will be provided.

The registration fee will be about 950 Sw. kronor.

Further information can be obtained from: 3rd Int'l. Congress on Industrial Waste Water and Wastes, Box 21060, S-100 31, Stockholm, Sweden.

## ***6th International Fermentation Symposium and 5th International Symposium on Yeasts***

***20-25 July 1980***

***London, Ontario (Canada)***

These two symposia will be held jointly at the University of Western Ontario. Official languages of both are English and French.

Topics covered by the Fermentation Symposium will include: Microbiology and Biochemistry,

Processes and Products, Bio-Engineering and Biotechnology.

The Symposium on Yeasts will cover the topics: Industrial and Agricultural Uses, Biochemistry of Yeasts, Genetics, Taxonomy and Ecology, Sporulation and Conjugation, and Cell cycle.

Information and registration forms for both conferences can be obtained from: K. Charbonneau, Executive Secretary, National Research Council, Conference Services, Ottawa, Canada K1A 0R6.

*21st Microsymposium on Macromolecules*

# **Ring-opening Polymerization of Heterocycles**

*22–26 September 1980*

*Karlovy Vary, Czechoslovakia*

At this microsymposium, there will be discussion of recent progress on the ring-opening polymerization of all kinds of heterocyclic compounds, including cyclic acetals, amines, ethers, sulfides, lactones, lactams, NCAs and similar monomers (but not siloxanes). Topics will include:

Kinetics and mechanism of polymerization, including side reactions.

Ring-chain equilibria and exchange reactions; formation of cyclic oligomers.

Polymerization of optically active monomers; stereoelective and stereoselective polymerization.

It is expected that there will be 14 invited lectures and 30–50 contributed papers (poster sessions). Summaries of contributed papers will be published in the program booklet and distributed in advance of the microsymposium.

Additional information can be obtained from the PMP Secretariat, c/o Institute of Macromolecular Chemistry, 162 06 Prague 616, Czechoslovakia.

Registration fees will be about the same as those for the preceding discussion conference on Polymer Networks.

*7th Discussion Conference on Macromolecules*

# **Polymer Networks**

*15–19 September 1980*

*Karlovy Vary, Czechoslovakia*

This conference will deal with formation, structure, and equilibrium of dynamic properties of polymer networks. Application of modern theoretical approaches and experimental techniques will be discussed, with special emphasis on networks from telechelic polymers. The conference will contain 12–15 invited lectures, a limited number of discussion papers presented in poster sessions, and two panel discussions by invited panel members. Topics to be dealt with are: **Network Models:** Recent developments in theoretical models of network formation and elasticity, and comparison with experimental results with well-defined networks.

**Structure of Real Networks:** Theoretical and experimental approaches to cyclisation, unequal reactivities of functional groups, and multi-component networks.

**Networks from Reactive Precursor Chains (Oligomers):** Features of network formation from reactive liquid polymers, and characterization of structure and physical properties.

Additional information will be provided by the PMM Secretariat, c/o Institute of Macromolecular Chemistry, 162 06 Prague 616, Czechoslovakia.

Approximate fees for the conference are \$85 for active participants, and \$50 for students. This includes admission to all scientific sessions, meeting materials, refreshments and social program (excepting an informal dinner). The fee for accompanying wives or husbands is \$30, including social program. These fees do not include attendance at the microsymposium following afterwards on Ring-opening Polymerization of Heterocycles.



# IUPAC ACTIVITIES AT A GLANCE

With the IUPAC General Assembly about to begin in early September, few commissions have met in recent months. Of those that have, here is what they reported.

## Notes & Projects

Now that the first CHEMRAWN conference (dealing with future sources of organic raw materials) has concluded and judged a great success, plans are gelling for subsequent conferences. The CHEMRAWN concept, dealing with CHEMical Research Applied to World Needs, may be expanded to include programs and studies other than symposia and workshops. Other subjects that might be encompassed into CHEMRAWN activities are chemistry of the environment, chemistry of the oceans, future sources of inorganic raw materials, renewable resources, and chemistry relating to medicine and health.

The second CHEMRAWN conference, tentatively entitled "World Conference on Chemistry, Agriculture & Food Supply", is expected to be held during 1981. The International Rice Research Institute has offered to hold CHEMRAWN II at the new International Convention Center in Manila, the Phillipines in March 1981. Emphasis of the conference is expected to be chemical research directed at the needs of Third World countries. Some views that may be discussed are anticipated greater interdependence of agricultural trading nations, and manufacture of fertilizers in small decentralized plants to bring the technological level of agriculture in developing countries up to that of Western Europe.

Preliminary plans are also underway for CHEMRAWN III. That conference will be held to discuss "Corrosion and Surface Protection". One possibility is to convene the conference in 1983, sponsored jointly with the International Corrosion Conference and the European Federation of Corrosion.

**The needs and interests of the chemical industry** are expected to be further incorporated into IUPAC activities by the formation of the *Committee on Chemistry & Industry*. A main objective of the committee is to provide a strong link between IUPAC Company Associates and IUPAC. Preliminary plans to approach this goal were discussed at the first meeting of the new committee, held in February.

The Committee on Chemistry & Industry will continue some projects begun by the informal group which preceded it, the International Company Associates Group. Following plans made by the superceded ICAG, the Committee hopes to improve the transfer of information from IUPAC to its Company Associates, and vice versa. This would encourage interest and participation of industrial chemists in IUPAC activities. The Committee expects to compile an information newsletter to be distributed to Company Associates. The newsletter will contain minutes of meetings of the Committee, and other information of interest for Company Associates.

The main focus of the new committee is considering new projects which may be of value to the chemical industry. Projects that have been proposed include: Application of Computer Technology in Chemistry;

Catalysis; Enzyme Application and Simulation; Chemical Aspects of Corrosion, Bioengineering, and Chemical Engineering. The Committee is discussing a collaboration with the European Federation of Chemical Engineering, and establishing a liaison with the CODATA Task Group on Data for the Chemical Industry. It is expected that Dr. M. Schönberg, a member of the CADATA Panel on Data for Industrial Needs, will attend the next meeting of the Committee on Chemistry & Industry (to be held at the Davos General Assembly), and present a report on activities planned by the Advisory Panel.

**The public's image of the chemical industry** was also considered by the Committee. It was felt that the chemical industry must present chemical matters to the public in a more positive manner than in the past. To encourage better relations with the public, the Committee advocated that an "open day" be arranged at all future IUPAC-sponsored symposia, at which general subjects would be discussed. The Committee examined a brochure containing a forum discussion between representatives of the German chemical industry and journalists, prepared by "Verband der Chemischen Industrie". Copies of that brochure were provided to those attending the meeting, and it may encourage the publication of similar material.

## Technical Studies & Reports

**Published melting point values for refractory metal oxides** will be assessed and "best values" will be recommended by a collaborative study group of the IUPAC *Commission on High Temperature and Refractory Materials*. The group was first formed in 1976, and expects to soon complete its report. It collects and analyzes melting point values compiled from the literature, or determined in recent experimental work sponsored by the Commission. The melting point is one of the most important characteristics of refractory materials, as it indicates the maximum temperature at which it may be used. But a wide variation in reported values is quite usual. Measurements conducted in the last 25 years are generally more consistent and reliable due to greater attention to temperature scales and standards, purity of samples, and environmental factors. Only data published since 1963 will be included in the report. Many values have been collected from less-known or interdisciplinary publications. The first draft of the report, prepared by Dr. Jan Hlavac and an associate reports melting points and recommends a "best value" for silica, titanium dioxide, zirconium oxide, alumina, yttria, and oxides of calcium, scandium and cobalt. Other members of the Commission may review melting point data for several other metal oxides. A final version of the paper, *Melting Temperatures of Refractory Oxides, Part I*, is expected to be ready in time for the September General Assembly.



A task group of the *Interunion Commission on Biothermodynamics* will prepare a report on the relevance, completeness, and quality of recent **thermodynamics data for biological sciences**. Work on the project has already started. The group also expects to initiate and coordinate work by other groups for compiling thermodynamics data relating to biological systems. The Commission does not expect to undertake compilation work, but where needed, will provide guidelines for those undertaking the compilation. Areas where the Commission feels that efforts are needed are:

- (1) Conduct a critical review of thermodynamics data for structural changes in macromolecules in biological systems.
- (2) Update and extend thermodynamics data compiled for the Krebs, Kornberg, and Burton metabolic pathways.
- (3) Evaluate and compile data for simple model compounds in biological systems.
- (4) Tabulate selected values of thermodynamics data for biological substances of most general occurrence.

## Nomenclature

Recommended **nomenclature for automated analysis** in clinical chemistry is being considered by the Commission on *Automation in Clinical Chemistry* and Commission on *Analytical Nomenclature*. The content of a document will be defined and work involved in producing a draft document will be divided between the commissions before the 30th IUPAC General Assembly, during which a joint meeting is planned for the two commissions.

An urgent need for uniform recommendations on **nomenclature and symbols in biothermodynamics** was apparent at the last meeting of the *Interunion Commission on Biothermodynamics* (a joint Commission of IUPAC, the Int'l. Union of Biochemistry, and the Int'l. Union of Pure & Applied Biophysics). The Commission noted that such recommendations must "make sense" for the majority of people working in biothermodynamics; otherwise, there would be little likelihood of universal acceptance. Recommendations will be based partly upon nomenclature recommended by the IUPAC Commission on Thermodynamics. However, considerable changes may be necessary to avoid awkward notation resulting when existing thermodynamics nomenclature rules are applied to complex biological systems. Several meetings are planned during the summer to discuss the required modifications, and final recommendations may be ready in 1980.

## Conference Sponsorship

Prof. Hjelm of the *Commission on Automation in Clinical Chemistry* has been organizing a symposium on "Factors affecting the choice of **instrumentation for clinical chemistry laboratories**" at the 3rd European Congress of Clinical Chemistry. The symposium may

be repeated at the October Southeast Asia and Pacific Congress of Clinical Biochemistry in Singapore.

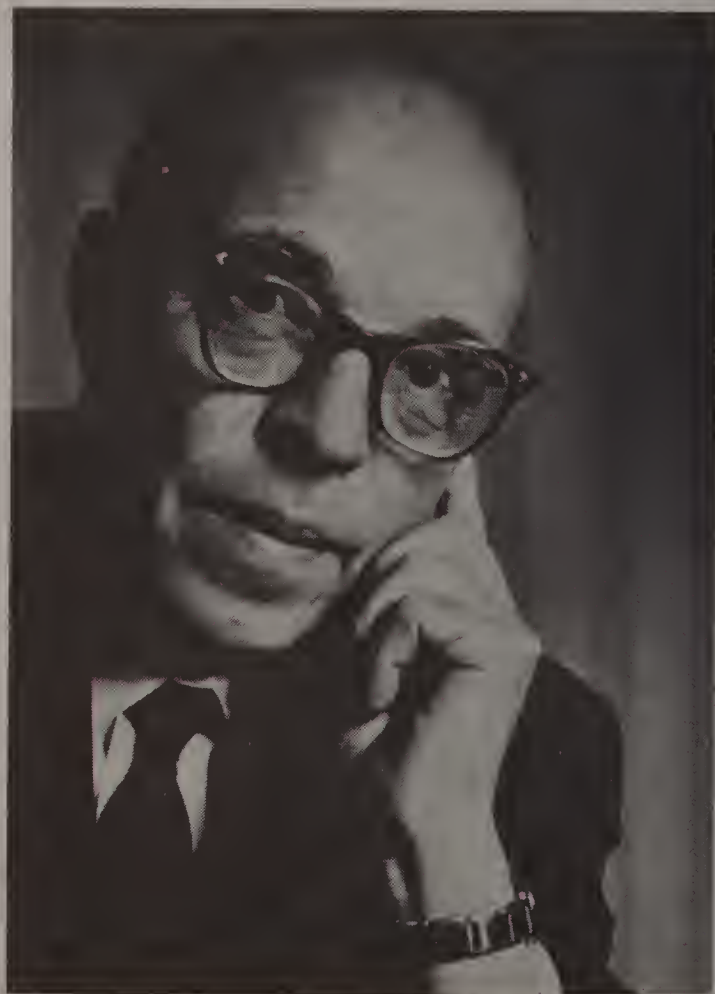
There will be a separate conference session on **thermodynamics of biochemical interest** at the IUPAC-sponsored Int'l. Conference on Chemical Thermodynamics, to be held August 1980 in the German Democratic Republic. Other forthcoming meetings of interest for biothermodynamicists were also mentioned at the last meeting of the *Interunion Commission on Biothermodynamics*. These included a workshop on **Calorimetry and Thermodynamics of Biochemical Systems**, sponsored by the European Molecular Biology Organization, and scheduled to be held in Genoa on September 17-26, 1979.

## People in Transition

**Dr. D. S. Young** plans to resign as chairman of the Commission on Automation in Clinical Chemistry because of increased professional responsibilities in his own country. **Prof. M. Hjelm**, now serving as a liaison between the Commission and the International federation of Clinical Chemistry, has been proposed to undertake the chairmanship.

**Prof. V. N. Kondratiev** former president of IUPAC and vice-director of the Institute of Chemical Physics of the USSR, died on February 22 at the age of 77. He had served as president of IUPAC from 1967 to 1969.

The Committee on Chemistry & Industry has appointed **Dr. G. Jäger** of Bayer AG as the first secretary of the committee, which was formed in 1977. Prof. Büchel will continue as chairman.



The late Prof. V. N. Kondratiev, former IUPAC president.



# TECHNICAL INFORMATION published by IUPAC

In recent years, many IUPAC Commissions have taken an active role in preparing technical reports on topics of special importance. Other Commissions have undertaken projects to tabulate data on solubilities, equilibrium constants, and on specific types of chemical compounds. And of course, IUPAC-sponsored conferences generally deal with technical topics, and published papers from these conferences provide an excellent survey of recent research activities.

The following index contains these three types of technical information that have been published by IUPAC within the last few years. Technical reports are indicated in bold type; chemical reference data in medium type; and conference papers in italics. Papers presented at IUPAC-sponsored conferences are generally published in the journal *Pure & Applied Chemistry*, but most are also collected into separate bound volumes which are available from Pergamon Press.

The traditional role for which IUPAC is best known is establishing rules for naming, symbolizing and representing chemical compounds. A comprehensive 3-page subject index of nomenclature has been published separately, and is available free-of-charge from the IUPAC secretariat.

## ACIDS/BASES

**Characteristics & application of redox indicators**  
*Pure & Appl. Chem.*, 50, No. 5 (1978)

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Dissociation Constants of Organic Bases in Aqueous Solution  
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## CARBOHYDRATES

*Plenary lectures from the 9th International Symposium on Carbohydrate Chemistry, April 1978*  
*Pure & Appl. Chem.*, 50, No. 11/12 (1978)

## CATALYSTS

*Invited lectures from the 2nd International Symposium on Preparation of Heterogenous Catalysts, September 1978*  
*Pure & Appl. Chem.*, 50, No. 9/10 (1978)

## CHEMICAL EDUCATION

*Plenary lectures from the International Congress on the Role of Laboratory Teaching in University Chemistry Courses*  
*Pure & Appl. Chem.*, 50, No. 6 (1978)

**Report on International Education of Medicinal Chemists**  
Technical Report No. 13, IUPAC, August 1974

## CHEMICAL INFORMATION

*Main lectures from the IUPAC Symposium on Techniques for Retrieval of Chemical Information, November 1976*  
*Pure & Appl. Chem.*, 49, No. 12 (1977)

## CHROMATOGRAPHY

**Comparison of Electrochemical Detection in Chromatography**  
*Pure & Appl. Chem.*, 51, No. 5 (1979)

## ELECTROCHEMISTRY

**Comparison of electrochemical detection in chromatography**  
*Pure & Appl. Chem.*, 51, No. 5 (1979)

**Standard Potential of the Silver-silver chloride electrode**  
*Pure & Appl. Chem.*, 50, No. 11/12 (1978)

**Polarographic half-wave potentials of inorganic substances in N,N'-dimethylformamide solvent**  
*Pure & Appl. Chem.*, 49, No. 6 (1977)

**Dimethylformamide: Purification, tests for purity and physical properties**  
*Pure & Appl. Chem.*, 49, No. 6 (1977)

**Voltammetric half-wave potentials in sulpholane solvent**  
**Sulpholane: purification, tests for purity, and properties**  
*Pure & Appl. Chem.*, 49, No. 2 (1977)

Selected Constants: Oxidation and Reduction Potentials of Inorganic Substances in Aqueous Solutions  
Chemical Data Series No. 13, Pergamon Press

Kinetic Parameters of Electrode Reactions of Metallic Compounds  
Chemical Data Series No. 11, Pergamon Press

## FOOD

**The Determination of Copper in Foodstuffs**  
*Pure & Appl. Chem.*, 51, No. 2 (1979)

**Recommended methods for determination of polycyclic aromatic hydrocarbons in foods**  
*Pure & Appl. Chem.*, 50, No. 11/12 (1978)

**Survey of analytical methods for estimation of artificial sweeteners in food**  
*Pure & Appl. Chem.*, 50, No. 3 (1978)

*Plenary lectures from the International Symposium on Advances in Smoking of Foods, September 1978*  
*Pure & Appl. Chem.*, 49, No. 11 (1977)

*Invited lectures at the 3rd International Symposium on Mycotoxins in Foodstuffs, September 1976*  
*Pure & Appl. Chem.*, 49, No. 11 (1977)

**Methods for Ochratoxins A and B in Barley**  
Technical Report No. 14, IUPAC, September 1976

**Guidelines for Testing Single-Cell-Protein destined as protein source for animal feed**  
Technical Report No. 12, IUPAC, August 1974

## GASES/VAPOURS

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**Reference materials for realization of physicochemical properties: Pressure-volume-temperature relationships**  
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*Selected lectures at the 3rd International meeting on Boron Chemistry, July 1976*  
*Pure & Appl. Chem.*, 49, No. 6 (1977)

### INORGANIC COMPLEXES

*Plenary lectures at the 18th International Conference on Coordination Chemistry, July 1977*  
*Pure & Appl. Chem.*, 51, No. 4 (1979)

Stability Constants of Metal Complexes  
Critical evaluation of equilibrium constants in solution  
*Pure & Appl. Chem.*, 49, No. 1 (1977)

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### MASS SPECTROMETRY

*Plenary lectures from the International Mass Spectrometry Symposium on Natural Products, August-September 1977*  
*Pure & Appl. Chem.*, 50, No. 3 (1978)  
*Pure & Appl. Chem.*, 50, No. 5 (1978)

### MICROCHEMICAL ANALYSIS

Methods for multi-element preconcentration from pure lead  
*Pure & Appl. Chem.*, 51, No. 5 (1979)

Separation and preconcentration of substances for inorganic trace analysis  
*Pure & Appl. Chem.*, 51, No. 5 (1979)

General aspects of trace analytical methods: Standard reference materials, contamination  
*Pure & Appl. Chem.*, 50, No. 11/12 (1978)

*Plenary lectures from the International Symposium on Microchemical Techniques, May 1977*  
*Pure & Appl. Chem.*, 50, No. 2 (1978)

An evaluation of methodology for analysis of high-purity mineral acids  
*Pure & Appl. Chem.*, 49, No. 6 (1977)

### NATURAL PRODUCTS

*Plenary lectures from the 11th International Symposium on Chemistry of Natural Products, September 1978*  
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*Lectures from the 5th International Symposium on Carotenoids, July 1978*

*Pure & Appl. Chem.*, 51, Nos. 3 & 4 (1979)

*Plenary lectures from the International Mass Spectrometry Symposium on Natural Products, August-September 1977*  
*Pure & Appl. Chem.*, 50, No. 3 (1978)  
*Pure & Appl. Chem.*, 50, No. 5 (1978)

*Plenary lectures at the International Symposium on Low Molecular Weight Sulfur-containing natural products, July 1976*  
*Pure & Appl. Chem.*, 49, No. 2 (1977)

### NUCLEAR CHEMISTRY

Reference materials for trace analysis by radioanalytical methods  
*Pure & Appl. Chem.*, 51, No. 5 (1979)

Procedure for measurement of 14-MeV neutron fluxes from accelerators for activation analysis  
*Pure & Appl. Chem.*, 49, No. 3 (1977)

### ORGANOMETALLIC CHEMISTRY

*Plenary lectures from 8th International Conference on Organometallic Chemistry, September 1977*  
*Pure & Appl. Chem.*, 50, No. 1 (1978)  
*Pure & Appl. Chem.*, 50, No. 8 (1978)

Stability Constants of Metal-Ion Complexes – Organic Ligands  
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A Critical View of Equilibrium Data for Proton and Metal Complexes of 1,10-Phenanthroline, 2,2'-Bipyridyl and related compounds  
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### PESTICIDES

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*Pure & Appl. Chem.*, 51, No. 4 (1979)

*Advances in Pesticide Science—Proceedings of the 4th International Congress on Pesticide Chemistry, July 1978*  
Published by Pergamon Press; *Plenary lectures, abstracts, Pesticide Residues*

Terminal residues of organochlorine, carbamate and organophosphorus insecticides  
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### PHOTOCHEMISTRY

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*Pure & Appl. Chem.*, 51, No. 2 (1979)

*Invited lectures at the 2nd IUPAC Symposium on Photochemical processes in Polymer Chemistry, June 1976*  
*Pure & Appl. Chem.*, 49, No. 4 (1977)

### PHYSICAL ORGANIC CHEMISTRY

*Lectures at the 4th IUPAC Conference on Physical Organic Chemistry, September 1978*  
*Pure & Appl. Chem.*, 51, No. 5 (1979)

### POLYMERS

Effect of filler on mechanical properties of rigid polyvinyl chloride  
*Pure & Appl. Chem.*, 51, No. 5 (1979)

Molecular characterization of polyethylene  
*Pure & Appl. Chem.*, 50, No. 11/12 (1978)

The effect of molecular orientation on mechanical properties of rubber-modified polystyrene  
*Pure & Appl. Chem.*, 50, No. 11/12 (1978)

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*Pure & Appl. Chem.*, 49, No. 7 (1977)



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Invited lectures at the 2nd IUPAC Symposium on Photochemical Processes in Polymer Chemistry, June 1976  
*Pure & Appl. Chem.*, 49, No. 4 (1977)

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## **IUPAC PUBLICATIONS**

# **Compendium of Analytical Nomenclature**

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### Nomenclature of Organic Chemistry

J. Rigaudy and S. P. Klesney – editors (February 1979) £30 (US\$60), 550 pages. This revised edition of "The Blue Book" of Nomenclature contains comprehensive and detailed recommendations of the IUPAC Commission on nomenclature of organic chemistry. It includes nomenclature of Hydrocarbons, Heterocyclic Systems; Coordination Compounds; Organometallic Compounds; Chains and rings with regular patterns of heteroatoms, Organic Compounds with phosphorus, arsenic, antimony or bismuth; Organoboron Compounds; Stereochemistry; Natural Products; Isotopically-modified compounds; Radicals; Characteristic groups with carbon, hydrogen, nitrogen, halogens, sulfur, selenium and tellurium.

### Standard Methods for the Analysis of Oils, Fats and Derivatives 6th Edition

C. Paquot, 140 pages (April 1979) £9 (US\$18). This volume describes methods for the determination of the density, principal constituents, foreign substances and additives, quality, stability, and other physical and chemical characteristics of liquid fats and oils and oils extracted from plants and seeds.

### Carbohydrate Chemistry

A. B. Foster – editor (March 1979) 136 pages, approx. £14 (US\$28). The eight plenary lectures presented at the ninth Int'l. Symposium on Carbohydrate Chemistry (10–14 April 1978, London) are contained in this volume.

### Pesticide Residues

H. Frehehse and H. Geissbuhler – editors, 100 pages (April 1979) £12.50 (US\$25). This publication contains all papers presented at Symposium VIa and VIb at the Fourth Int'l. Congress of Pesticide Chemistry, held in Zurich on 24–28 July 1978. These lectures are also included in the publication "Advances in Pesticide Science", which contains the complete proceedings of the conference.

### Critical Evaluation of Equilibrium Constants involving 8-Hydroxy Quinoline and its Metal Chelates

J. Sary, A. Zolotov and O. M. Petrikhin, 40 pages (June 1979) £6 (US\$12). The aim of this book is to compile, discuss and critically evaluate published data on the dissociation, solubility, and liquid–liquid distribution of oxine and its metal chelates.

### 26th Int'l. Congress of Pure & Applied Chemistry – Analytical Chemistry, 1977

T. Takeuchi – editor, 76 pages (June 1979) £12 (US\$24). Six lectures presented at the Analytical Chemistry session of the 26th Int'l. Congress of Pure & Applied Chemistry are contained in this volume. The topics are: Microcomputers in laboratory automation; Applications of fast kinetics relaxation techniques in chemistry and biochemistry; Correlation NMR spectroscopy; Chelating agents for metal buffering and analysis; Current topics in organic mass spectrometry; and recent developments in atomic fluorescent spectroscopy.

### Krypton, Xenon and Radon Gas Solubilities

H. L. Clever, 378 pages (June 1979) £50 (US\$100). This reference volume contains available experimental solubility data of krypton, xenon and radon gas in liquids as reported in the scientific literature. It provides tables of mole fraction solubility data for the systems studied over a temperature range, and tables of tentative or recommended solubility data when reported by two or more laboratories over the same range of temperature and pressure.

### Silver Azide, Cyanide, Cyanamides, Cyanate, Selenocyanate and Thiocyanate—Solubilities

M. Salomon – editor, 258 pages (March 1979) £50 (US\$100). Numerical values and critical analysis of solubility data are provided for the silver halides and pseudo-halides in all solvents except molten salts and slags.

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# **INTERNATIONAL UNION OF PURE and APPLIED CHEMISTRY**

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The International Union of Pure and Applied Chemistry (IUPAC), formed in 1919, is a voluntary, nongovernmental, nonprofit association of organizations, each of which represents the chemists of a member country.

Its objectives are:

- to promote continuing cooperation among the chemists of the member countries;
- to study topics of international importance to pure and applied chemistry which need regulation, standardization, or codification;
- to cooperate with other international organizations which deal with topics of a chemical nature;
- to contribute to the advancement of pure and applied chemistry in all its aspects.

The membership of IUPAC presently comprises 42 countries, each represented by a national organization, such as an academy of science or research council.

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# Chemistry International

The news magazine of the International Union  
of Pure and Applied Chemistry (IUPAC)



1979, No. 3



Pergamon Press

# CHEMISTRY INTERNATIONAL

was formerly published under the title

## IUPAC Information Bulletin

EDITOR: Dr. Martin Gellender

### SUBSCRIPTIONS

The first issue of Chemistry International has been preceded by two 1979 issues with the former title, the IUPAC Information Bulletin.

Six issues of Chemistry International will be published in 1980. Annual subscription rate including postage is US\$20 for individuals, and US\$35 for libraries. Microfiche subscriptions are available simultaneously with the printed edition, and microfilm at the end of the subscription year. Subscription orders may be placed directly with IUPAC's official publisher, Pergamon Press Ltd, Headington Hill Hall, Oxford OX3 0BW, UK.

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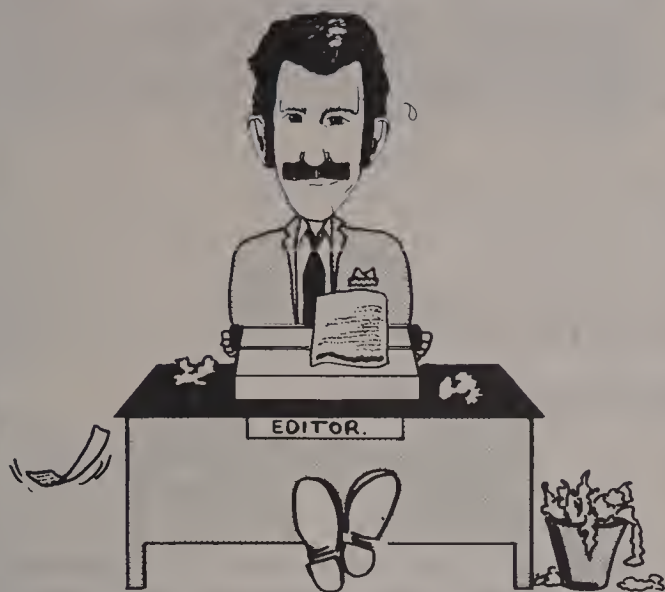
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## THE EDITOR'S DESK

### The Earth below, the sky above

*More and more, it has become apparent that mankind will face serious technological problems in the decades ahead. These problems — limited natural resources, pollution, vulnerability of food supply to environmental conditions — were once considered regional. Clearly, they are not.*

*Declining availability of petroleum-based hydrocarbons affects people in all nations. Advances in science and technology that lead to alternative energy supplies will be of crucial importance to people everywhere. So too has it become apparent that many nations share the same waterways, and face the same problems of monitoring and controlling toxic waste products. We all breathe the same air, and often inhale the same pollution. The same chemically-vulnerable layer of ozone in the upper atmosphere shields us from the sun's ultraviolet radiation.*

*As the age of petroleum and the 20th century simultaneously draw to a close, we will experience an unprecedented period in human history. This period will pose enormous technological challenges, requiring a massive effort by chemists and other scientists to develop new technologies. International scientific cooperation will become increasingly important to achieve maximum progress with limited technological facilities, manpower and time. As a central, non-political body in chemistry, the International Union of Pure & Applied Chemistry (IUPAC) is in a logical position to play a prominent role. IUPAC is also in an obvious position to publish a newsmagazine — this magazine — about developments in chemistry of international significance. Chemistry International will discuss advances in chemical research that could affect the lives of millions of people, and the role that IUPAC performs. I hope that you read about these developments in upcoming issues of Chemistry International.*

*Martin Jellender*

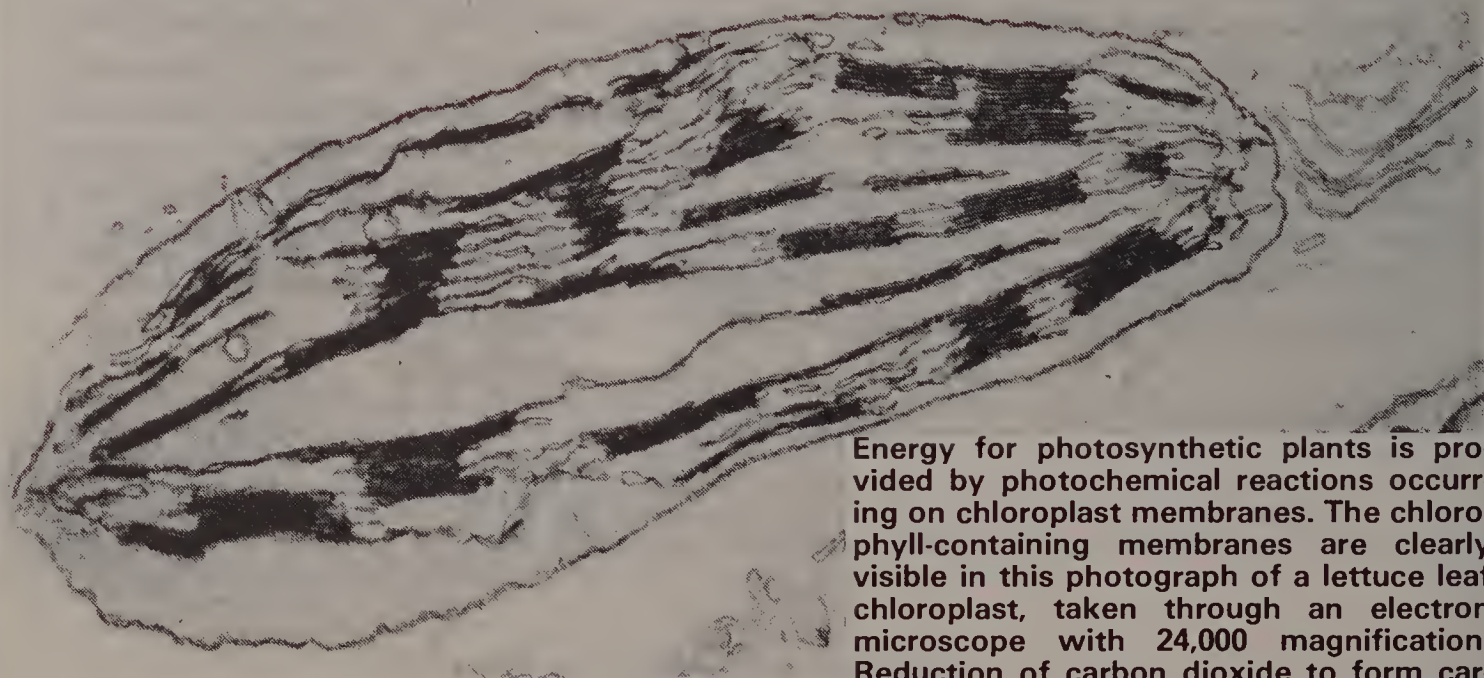
## Chemically-improved photosynthesis could be the key to solar-derived fuels

Utilization of solar energy by plants will need to be improved if agricultural material is to be the primary medium for harnessing solar energy, as well as supplying nutritional needs of the world's population. Liquid fuels derived by fermentation of plant carbohydrate are being used in a widening series of programs in Brazil and the US, and wood will continue to be the most important energy source for much of the earth's population. Sunlight incident on the earth's surface contains about ten times the present global energy consumption, but only 0.1% of solar radiation is converted to chemical energy stored in plant matter. Efficiency of photosynthetic energy conversion must be increased if plants grown as a renewable energy source are to compete for arable land against food production. Production of edible plant matter alone will need to double in the next 25 years to keep pace with population growth.

Improving photosynthesis in plants and artificial chemical systems have become the focus of a major international effort by biochemists and chemists. For example, a group in Japan

has made semi-biological photocells to generate electricity directly from sunlight. These contain tin oxide electrodes coated with chlorophyll and phospholipids. Another possible "photosynthetic bio-engineering" application is production of hydrogen by genetically-modified algae or artificial membranes. Faster plant growth might result from genetic mutations induced by chemicals or radiation, with procedures similar to those already used for developing mutant bacteria and fungi.

At the present time, much of the photochemistry of photosynthesis is still unknown or poorly understood. Fundamental knowledge that has been gained is often veiled in biochemical jargon, and many chemists are likely to be deterred by details of biochemical reaction pathways. Nonetheless, advances in photosynthesis research will have direct implications for chemists, and ultimately, for much of the world's population. So, what is known about photosynthesis: its chemistry, photochemistry, and electrochemistry? That can be found in recent articles in publications



Energy for photosynthetic plants is provided by photochemical reactions occurring on chloroplast membranes. The chlorophyll-containing membranes are clearly visible in this photograph of a lettuce chloroplast, taken through an electron microscope with 24,000 magnification. Reduction of carbon dioxide to form carbohydrates occurs in the cell cytoplasm surrounding the membranes (*photo from Centre National de la Recherche Scientifique, Paris*).



of major chemistry organizations. One, *Photosynthesis and Plant Productivity* (by Dr. Israel Zeitlich of Yale University, USA), appeared in the Feb. 5th issue of the American Chemical Society magazine, Chemical & Engineering News. Another *Photosynthesis and Molecular Organization* (by Jean Lavorel of Centre National de la Recherche Scientifique, France), appeared in CNRS Research (Number 8, 1978). Here, in very brief form, is what these articles said.

Photosynthesis is the reduction of carbon dioxide from the air to produce carbohydrates and cellulose. It is an endothermic reaction, the energy of which is provided by the absorption of visible radiation in sunlight. Products of photosynthesis comprise 90-95% the dry weight of most plants (the remaining 5-10% being minerals and nitrogen obtained from the soil). The overall reaction of photosynthesis,



requires 112 kcal/mole of energy. Light absorbed by photosynthetic plants has a minimum photon energy of 40 kcal/mole, so at least three photon of radiation must be absorbed for each oxygen atom liberated. In actual plants, the minimum requirement under optimal conditions is 8 photons.

The biochemical processes of photosynthesis are largely the same in all green plants, including one-celled algae. In all, photosynthesis occurs in cellular substructures called chloroplasts. Within a chloroplast, there are closed membrane structures (thylakoids), which are found universally in all photosynthetic organisms. Thylakoids are even found in primitive photosynthetic bacteria, which do not have chloroplasts. Thylakoids are often stacked

as disc-shaped bodies 5-10 microns diameter, called grana.

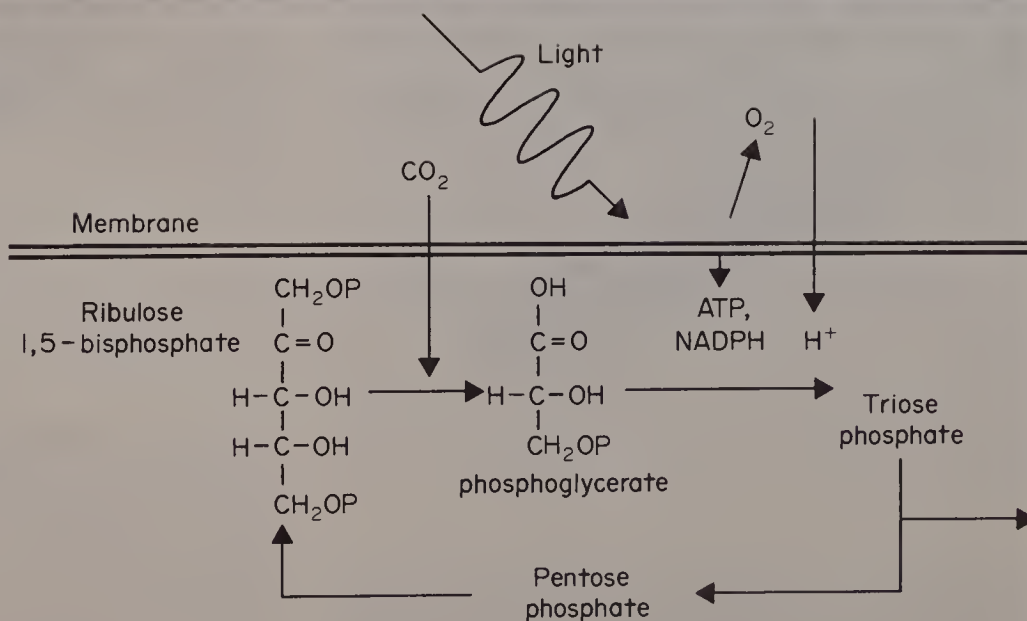
The light absorbing pigment, chlorophyll, is contained within the membrane structures of the chloroplast. These act as antennae for light, and transfer energy of absorbed photons to a photochemical center. About 300 molecules of chlorophyll are contained within each photosynthetic unit, and eight photosynthetic units must absorb a photon and transfer energy in order to release one molecule of oxygen.

Through a complex series of energy transfers, this absorbed energy is utilized to bring about two distinct half-reactions: oxidation of water, occurring on *thylakoid membranes* of the chloroplast, and reduction of carbon dioxide carried out by enzymes in the liquid surrounding chloroplast membranes.

When water is oxidized, hydrogen is transferred from water molecules to the intermediate NADP (Nicotinamide-Adenine Dinucleotide Phosphate), forming NADPH. Energy remaining from the hydrogen transfer converts ADP (Adenine DiPhosphate) to the higher energy form, ATP (Adenine TriPhosphate). These two compounds, NADPH and ATP store "reducing power" and energy in the cell. They provide energy for reduction of carbon dioxide into carbohydrates. Indeed, the reduction of carbon dioxide does not require light. It can be brought about by mixing ATP with NADPH with the enzyme-containing liquid released by rupturing the outside chloroplast membrane. The enzyme responsible for photosynthetic CO<sub>2</sub> fixation, ribulose, 1,5-biophosphatecarboxylase, is contained in the fluid part of the chloroplast (the stroma). It is a soluble protein with an unusually high molecular weight of about 560,000.

Not all photosynthetic organisms release oxygen. Photosynthetic bacteria are anaerobic, and evolve no oxygen. Instead, they oxidize various organic or inorganic material while

Absorption of light by chlorophyll channels energy to chloroplast membranes, where the high-energy intermediate ATP and reductant NADPH are generated, and oxygen is released. Reduction of carbon dioxide occurs in the solution surrounding chloroplast membranes. Most plants incorporate CO<sub>2</sub> initially into a three-carbon phosphoglycerate, as shown here. But other plants utilize a different, more efficient, sequence of reactions to fix carbon dioxide initially as a four-carbon compound.





reducing carbon dioxide. The oxidation of water or other substrate is accompanied by transfer of hydrogen ions and electrons. Electron transport is believed to be within the plane of the membrane, while hydrogen ions are "pumped" across the membrane into the enclosed fluid. This is accompanied by the appearance of an electric field across the membrane with an estimated potential difference of 200 mV. In addition, movement of hydrogen and other ions gives rise to a pH difference inside and outside the membrane of as much as three pH units.

Electron, hydrogen and energy transport capture the energy of sunlight in the high-energy intermediate ATP and in the reductant NADPH. From here, we shift our attention from the membrane of the chloroplast to the solution, where carbon dioxide fixation occurs.

The mechanism of  $\text{CO}_2$  fixation has been clarified by studies with isotopically-labelled molecules. One of the most important experiments examined the outcome when  $^{14}\text{CO}_6$  was supplied to plant leaves illuminated with sunlight. Most plants produced three-carbon phosphoglycerate molecules as the first detectable product containing radioactive  $^{14}\text{C}$ .

The three-carbon compound, 3-phospho-D-glyceric acid, is formed by the enzyme-catalyzed reaction of ribulose 1,5-bisphosphate with carbon dioxide. The product is reduced to a triose phosphate carbohydrate with energy supplied by ATP and NADPH. Each molecule of  $\text{CO}_6$  fixed requires three molecules of ATP and two of NADPH. Most of the triose phosphate carbohydrate is converted to pentose phosphate, used to regenerate ribulose 1,5-bisphosphate. Some triose phosphate is converted to higher carbohydrates comprising the bulk of the plant's mass.

Most plants operate through this same biochemical starting point. But not all. There appears to be two basic types of green plants, having different biochemical pathways for photosynthesis and possessing very different characteristics. There are the so-called  $\text{C}_3$  plants, like alfalfa, soybean, potato and wheat, producing the same initial three carbon product. And there are plants which produce four-carbon malate and aspartate compounds as the first photosynthetic products. Corn, sugarcane, and some weeds are  $\text{C}_4$  plants.

From the view of photosynthetic efficiency,

$\text{C}_4$  plants are clearly superior. Their leaves can assimilate carbon dioxide at about twice the rate of  $\text{C}_3$  plants. At low  $\text{CO}_2$  concentrations, oxygen does not inhibit photosynthesis by competing with  $\text{CO}_2$  for enzyme sites, as occurs in  $\text{C}_3$  plants. Under environmental conditions usually encountered,  $\text{C}_4$  crops have *two or three times* the seasonal growth rates (dry plant mass produced per square metre of land per week). One hectare of sugar cane, for example, can provide about 80,000 kg of dry plant mass per year, while most  $\text{C}_3$  crops provide about 30,000 kg/hectare under good conditions.

Why do  $\text{C}_4$  plants have a photosynthetic efficiency that is so much higher? All plants must maintain metabolic processes when sunlight is not available, and obtain energy by oxidizing photosynthesis products back to carbon dioxide. This process is called "dark respiration". But  $\text{C}_3$  plants also carry out rapid respiration of  $\text{CO}_2$  in the presence of light. Early investigators assumed that this "photorespiration" occurs through a similar biochemical pathway as dark respiration. Recent studies show this is not true, and that photorespiration occurs three to five times more rapidly than dark respiration. Photorespiration appears to perform no necessary function. As much as half the  $\text{CO}_2$  assimilated by  $\text{C}_3$  plants is released by photorespiration, while  $\text{C}_4$  plants undertake photorespiration at an insignificant rate.

Many researchers have speculated why  $\text{C}_3$  plants undertake photorespiration at all, since it is such a wasteful process. One theory is that photorespiration is an evolutionary burden remaining from atmospheric conditions which prevailed millions of years ago. With high levels of  $\text{CO}_2$  in the air, low oxygen levels and strong sunlight, photorespiration would have been so reduced that  $\text{C}_3$  and  $\text{C}_4$  plants would have carried out photosynthesis at similar rates. Only when conditions changed to those now existing would the biochemical pathways for  $\text{C}_3$  plants be a disadvantage in limiting their growth.

In coming decades, modern technological methods could possibly modify plant growth in ways that evolution has failed to do in millions of years. Of course, evolution is concerned only with survival, comments Dr. Zeitlich, (author of the article in *Chemical & Engineering News*). It is mankind that is concerned with maximizing growth.



# Chemists copy natural compounds to make safer, more effective insecticides

When DDT was first introduced, it seemed to be a miraculous chemical agent which could, for the first time, effectively control a wide range of insect pests, saving millions of lives by eradicating insect-borne disease and dramatically improving crop yields. It was, but the limitations of DDT and other organochlorine compounds (and later, organophosphorous insecticides) soon became apparent. These left toxic residues in soil and food, were a hazard to birds and wildlife, and declined in effectiveness. Insects with a greater tolerance to the insecticide survived, and passed this tolerance on to their offspring.

These limitations of conventional insecticides have led researchers to examine insecticide compounds that occur naturally in the environment. It is not widely appreciated that many insect species have developed their own chemical warfare methods for repelling or killing predator insects. Some species of beetles, for example, possess glands that secrete insecticidal compounds, which are sprayed or brushed onto their enemies. The secretions are generally mixtures of several compounds; some are insect poisons, but others provide a gluey consistency holding the toxic liquid on the insect's body, or aiding penetration through the waxy covering of the insect body.

Many studies on natural insecticides are joint projects undertaken in laboratories and field stations in different countries. In one project, for example, secretions of termite soldiers are

examined in Brazil and analyzed in laboratories at the University of Southampton in the UK. Prof. R. Baker of the University of Southampton, speaking at a meeting of the U.K. Chemical Society on *Natural and Synthetic Compounds Affecting Insects*, noted that insecticidal secretions produced by insects are unlikely to be synthesized in large quantities for direct application as commercial insecticides. Most do not have sufficient toxicity or stability to compare favorably with conventional insecticides, but they could provide valuable clues to the structure of chemical compounds that will be more lethal to insects, and less toxic to animals.

Increasing the potency of a natural product has not been the *only* goal of chemical researchers developing synthetic analogs. Developers of pyrethroid insecticides have been striving to approach the extremely high insect toxicity of natural pyrethroids (the most active compound is Pyrethrin I). These compounds occur in a species of daisy native to Africa. Why this flower produces this compound at all is a mystery. Pyrethroids are produced and stored in the interior of the flower, eliminating any potential advantage that the plant could gain by repelling insect attack. But yet, it seems strange that the flower should produce by chance a waste product so deadly to a broad range of insects. Indeed, the initial problem faced by research chemists was not to produce chemical analogues with higher insect toxicity, as was

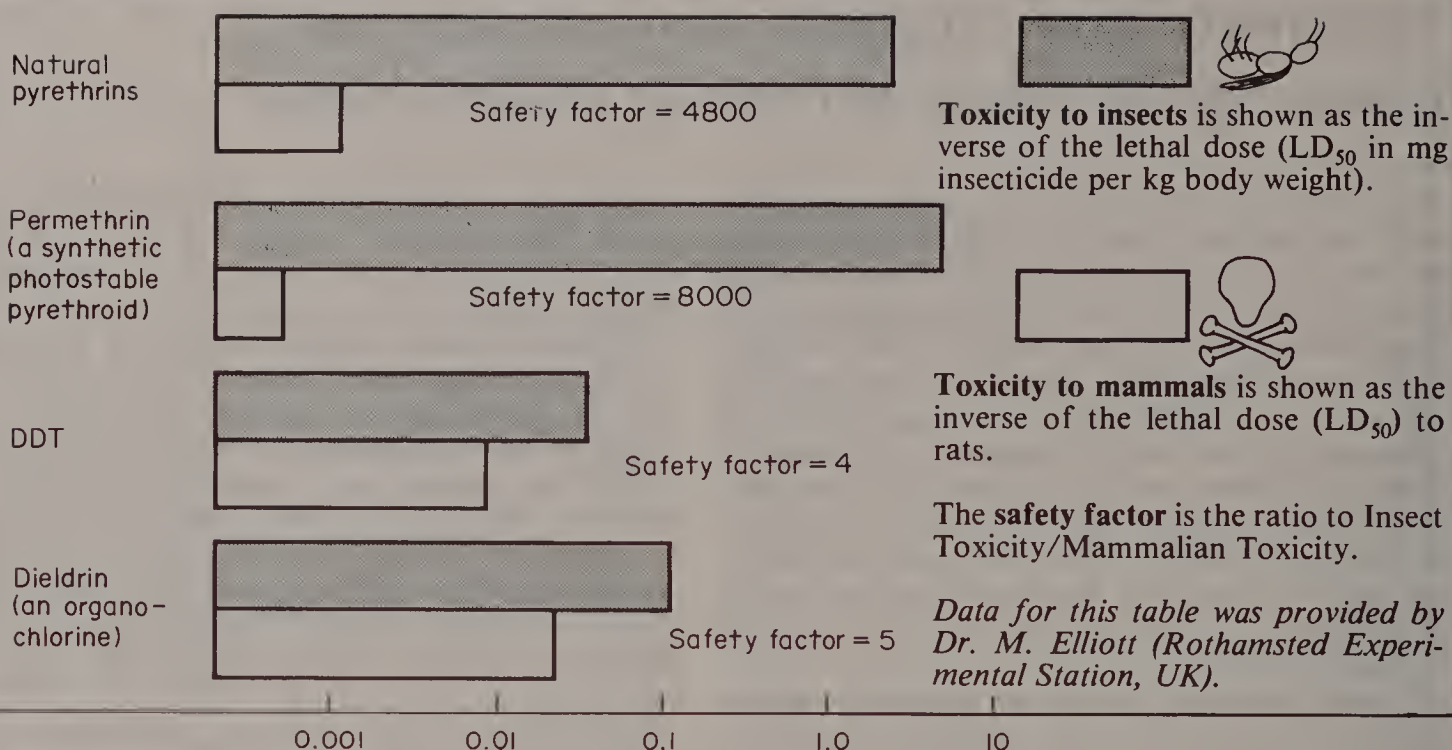


Chemical insect control is practised by some insect species, as well as by humans. These soldier termites can kill or immobilize attacking insects with poisonous compounds secreted by a gland in the termite's body. The secretions contain a diverse range of organic compounds, many of which may have insecticidal properties. Some are simple aliphatic ketones. Others are monoterpene, sesquiterpene and diterpene compounds containing various functionalities such as



alcohols, ethers, acetates and nitro compounds. The mixture is either brushed on the insect's adversary from appendages on the termite's head or sprayed from an elongated nozzle. (photo courtesy of Prof. Raymond Baker, University of Southampton, UK).



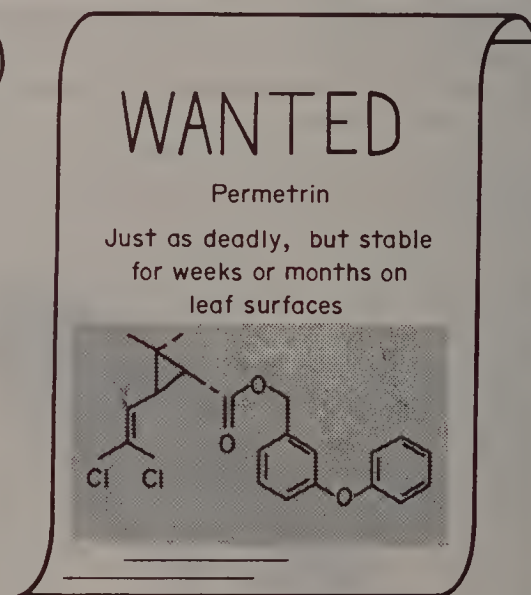
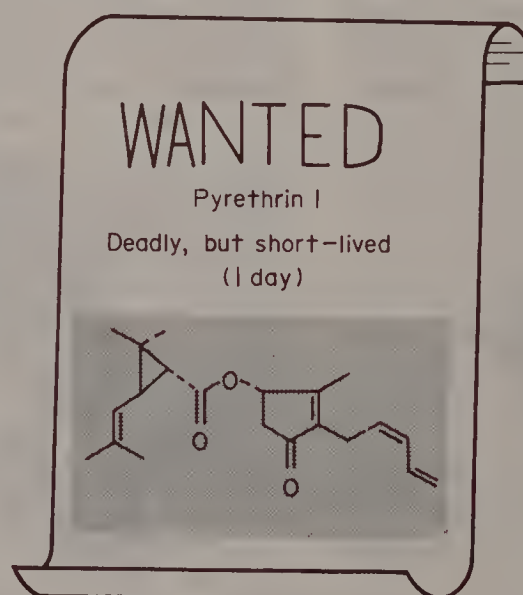


emphasized by Dr. M. Elliott (of Rothamsted Experimental Station, in Herts, England), but to synthesize *stable* compounds that were nearly as effective. That problem is being solved. In 1967, the first synthetic pyrethroid insecticide was produced with an activity comparable to natural pyrethrin. Within the last few years, chemists have been able to prepare pyrethroid insecticides that resist oxidation and

photochemical breakdown, as well as killing insects in extremely low doses. Some of these photostable pyrethroids are already being produced commercially, and are being used in rapidly increasing amounts. It now appears probable that in the 1980's, synthetic pyrethroids will have an importance comparable with organochlorine, organophosphate and carbamate compounds—until now the only

## A portrait of two compounds most deadly to the insect world

Pyrethrin I is the most lethal compound of an insecticide mixture extracted from the flower *Chrysanthemum cinerariaefolium* (another component of the mixture, Pyrethrin II, provides more rapid knock-down of flying insects). Unfortunately, Pyrethrin I rapidly decomposes when exposed to sunlight and air. The molecule is an ester, whose instability is due to two light-sensitive centres in the molecule. One is the isobutenyl side chain on the acid-derived part of the molecule; the other is the pentadienyl side chain of the alcoholic component.



To confer stability to the molecule, researchers have prepared chemical analogues with modified chemical structures containing no photo-sensitive centres. Many have been synthesized, but most have only a small fraction of the potency of Pyrethrin I. One stable molecule which retains high toxicity against insects is Permethrin.

Although pyrethroid compounds have physical properties similar to chlorinated hydrocarbon insecticides, they are relatively non-toxic to mammals. While the compounds may be toxic to the nervous system, their rapid metabolism prevents accumulation of harmful concentrations. Pyrethroids are rapidly broken down into polar compounds, which are excreted.

The small stable pyrethroids, like Permethrin, are

not so stable that they persist for years in the environment, as do organochlorine insecticides. In soil, photostable pyrethroids are rapidly decomposed by bacteria. On leaf surfaces and seed coatings, they can retain their effectiveness for several months.

Residual concentrations of pyrethrins (and compounds used to augment their effect, such as piperonyl butoxide), are readily measured by well-proven, as well as experimental, chemical techniques. Methods for measuring pyrethrin concentrations in milk, fish, eggs, meat and meat byproducts are outlined in a report prepared by Dr. Kenneth Hill (of the Agricultural Research Service in Maryland, USA) for the IUPAC Commission on Pesticide Residue Analysis, appearing in *Pure & Applied Chemistry*, 1979, No. 7, p.1615.



practical insecticides for wide-scale use.

Other developments also seem well along the way to commercial application. Recent breakthroughs have determined the complex chemical components of several insect pheromones and hormones. These compounds, or mixtures of compounds, normally control insect behavior. Eventually, pheromones and insect hormones may be made synthetically, and applied on a wide scale to disrupt insect mating, communication, or moulting.

A crucial question remains to be answered about synthetic analogues, natural insecticides, pheromones or insect hormones. Will insects develop tolerance to these compounds as they have against some conventional insecticides? If so, then further research and development will be needed to develop yet another generation of insecticide compounds.

Resistance to pyrethroid insecticides has already been observed in one case in Denmark,

where they were used extensively to control flies resistant to conventional insecticides. "Although resistance in pests of agricultural crops is less well documented", noted Dr. Elliott in a 1976 paper published in *Environmental Health Perspectives*, "there is no reason to suppose that the mechanisms involved will not extend to any pest continually exposed to a toxicant . . . new, or well established."

Until there is sufficient experience with the new generation of insecticides to understand the extent of developing resistance, it would certainly be prudent for governments to ensure that the new insecticides are used properly, so as to minimize the chance that tolerant insect species could develop. Otherwise, promising new insecticides now approaching worldwide use could prove only to be another brilliant—but temporary—advance in a timeless war that is never won.

## IUPAC launches its largest project to collect and evaluate data

The most comprehensive collection and evaluation of solubility measurements ever undertaken is now getting under way. When complete, the *Solubility Data Series* should include data on virtually every compound (solid, liquid or gas) that dissolves in some solvent, for which experimental data has been published. About 8-10 volumes of the Series (averaging 350 pages each) will be published each year, for a period of about 10 years.

"... We believe that this is the largest single IUPAC project ever undertaken", points out Prof. A. S. Kertes, chairman of the IUPAC Subcommittee on Solubility Data. "Considering the wide scope of the Series and the tremendous amount of work invested in it by a large number of scientists from all over the world, I believe that the volumes generated by us will still be on reference bookshelves of science libraries well into the next century. It is simply inconceivable that a scientific work of such dimensions can be repeated within the coming 80-100 years. It may not have to be. Once the series has been completed, we plan to update it by publication of supplements."

Prof. Kertes notes that "... this project is based on a conceptually new approach in handling numerical data in science and technology". Each solute/solvent system will be described in two parts. Firstly, data sheets present *all reliable experimental values*. A typical data sheet lists the name, formula and Chemical Abstracts registry number of all compounds in solution, identifies the person who compiled the information, and presents experimental values as they appear in the primary information source.

Secondly, an expert for that system discusses

and evaluates the quality of available data, limitations of the experimental method, and reproducibility of measured values. Values thought to represent *the best available data* are presented, and graphical plots are provided where possible.

The Series is by far the most comprehensive collection of solubility data, and it also incorporates the most stringent standards for evaluation. The original data compiled by one investigator (presented in data sheets) is evaluated by a second, and his analysis is appraised by another individual before it is included.

Volumes in the Solubility Data Series are edited by members of the IUPAC Subcommittee on Solubility Data, assisted by 150 internationally-recognized experts, serving as a board of editors, compilers, and evaluators. Prof. Kertes (of the Hebrew University of Jerusalem) is serving as editor-in-chief, and Prof. A. F. Barton (of Murdoch University in Western Australia) is presently on sabbatical, assisting IUPAC with production of the Series.

The Solubility Data Series in a new undertaking, entirely independent of IUPAC's Chemical Data Series. The first volumes of the Solubility Series were published in June. A listing of the first 18 volumes being prepared, and additional information on the entire series, is contained in a brochure available from Dr. Colin Drayton, Managing Editor, Physical Sciences, Pergamon Press Ltd., Headington Hill Hall, Oxford OX3 0BW, UK. The volumes will be sold individually, at a cost of US\$100 for libraries or US\$25 for individuals. Alternately, subscriptions are being offered for the entire Series, one year, or two years.



# A few clues, and simple detective work identify monocyclic compounds

If you happen to see a chemist leave his lab with watery eyes, and blurt "Azete" through a handkerchief held over his nose, he's probably not caught a cold. More likely, he has spilled his reaction mixture over his laboratory bench. His hasty departure and nauseous expression would indicate a secondary amine as the main component of the mixture. His exclamation is *not* a sneeze, but the name of the compound in question. Its name confirms immediately that it was in fact a secondary amine, and that the nitrogen atom was contained in an unsaturated four-member ring. He has correctly named the compound according to the systematic method recently revised by the IUPAC Commission on

Nomenclature of Organic Chemistry. That method extends existing rules for naming one-ring heterocyclic molecules (originally conceived in 1887 by Hantzsch and Widman) to encompass all such compounds containing up to ten non-metallic atoms in a cyclical backbone.

The system in use until now has imposed several important limitations on naming one-ring heterocyclic molecules. To correct these shortcomings, substantial changes are recommended in the report "Revision of the Extended Hantzsch-Widman System of Nomenclature for Heteromonocycles", published in the IUPAC journal *Pure & Applied Chemistry* (Vol. 51, No. 9, 1979, p. 1995). Nomenclature

## How to name cyclical compounds

Table 2

RING

SATURATED

UNSAT.

SIZE

Table 1

HETEROATOM

PREFIX

Non-metals:

Fluorine

Chlorine

Bromine

Iodine

Oxygen

Sulfur

Selenium

Tellurium

Nitrogen

Phosphorus

Fluora

Chlora

Broma

Ioda

Oxa

Thia

Selena

Tellura

Aza

Phospha

3 atoms

4 atoms

5 atoms

6 atoms

7 atoms

8 atoms

9 atoms

10 atoms

irane

etane

olane

ixane

epane

ocane

onane

ecane

irine

ete

ole

ixine

epine

ocine

onine

ecine

PREFIX STEM

Example 1

Common name: Pyridine

Heteroatom: Nitrogen

(prefix; Aza)

6-member ring, Unsat.

(stem: ixine)

**Azixine**

c1ccncc1

Example 2

Heteroatoms: 3 Nitrogen and Silicon

(prefixes: Aza & Sila)

5-member ring, Sat'd.

(Stem: olane)

**1,2,4,3-Triazasilolane**

C1=NN(Si)N1

Metals:

Arsenic

Antimony

Bismuth

Silicon

Germanium

Tin

Lead

Boron

Mercury

Arsa

Stiba

Bisma

Sila

Germa

Stanna

Plumba

Bora

Mercura



rules recommended by this report are provisional. Improvements suggested by practising chemists throughout the world will be taken into consideration, and may be incorporated, before the report is published in final form.

Comments can be sent to the secretary of the Commission on Nomenclature of Organic Chemistry, Mr. S. P. Klesney, Central Report Index, 566 Bldg, Dow Chemical Company, Midland, Michigan 48640, USA.

Proposed changes in the revised nomenclature system allow nitrogen-containing compounds with more than 5 atoms in the ring backbone to be named. Common nitrogen-bearing compounds such as pyridine and morpholine are readily dealt with, although systematic designations are not intended to displace well-accepted names. The proposed rules overcome two other limitations: numbering of atoms within the ring backbone is consistent with that used for multi-ringed molecular structures, and the naming system can be applied to compounds containing cationic halogen atoms within the ring.

The proposed rules allow most compounds with a cyclic one-ring structure to be named quite easily. For a complete discussion of the proposed nomenclature system for heteromonocycles, the reader should refer to the report in *Pure & Applied Chemistry*. However, basic principles of naming one-ring heterocycles can be explained simply.

The first step is to identify atoms within the cyclical backbone other than carbon (so-called "heteroatoms"). If only one is present, naming is very straightforward. A prefix for that heteroatom is obtained (from Table 1 shown here). Its last letter is omitted to form the first part of the compound's name. The second part, the name stem excerpted from Table 2, conveys the total number of atoms forming the ring backbone. The name stem also indicates whether the ring has no double bonds (is completely saturated), or has the maximum possible number of double bonds. So for example, the common solvent pyridine (a six-member unsaturated ring with a nitrogen heteroatom) would systematically be named "Azixine".

The presence of several heteroatoms of the same types is indicated by the prefix "di" or "tri". Their positions in the ring structure are denoted by numbers. Counting is started from the position of one heteroatom, and proceeds in the direction that gives the lowest position numbers to other heteroatoms. Pyrimidine, for example, has a six-membered ring structure containing two nitrogen atoms. It is fully unsaturated. Its systematic name is 1,3-Diazixine.

If two (or more) kinds of heteroatoms are present in the ring (say nitrogen and silicon, as shown in Example 2), both prefixes are listed in order of their appearance in Table 1. Although a compound may have the maximum possible number of double bonds, an isolated atom in the ring may be fully saturated by hydrogen. The location of a saturated atom is given by the position number relative to the heteroatom. For example, 2H-Phosphole has a five-membered unsaturated ring structure. Adjacent to the phosphorus heteroatom (in position 2) is a fully saturated carbon atom.

For partially unsaturated compounds, the name stem of the fully unsaturated compound is selected. The presence of hydrogen at saturated ring atoms is indicated by placing the word "hydro", "dihydro" etc before the name of the compound with the position number at which saturation occurs (Example, 1,2-Dihydroazete).

No doubt, if you have read this far, you would like to try some simple detective work of your own. To help you is all the information you need to name heteromonocycles (in Tables 1 and 2) and two sample structures for which systematic names are provided. If you find that the brief and simplified summary of proposed nomenclature rules presented here does not provide enough information, you might wish to refer to the complete nomenclature recommendations published this month in *Pure & Applied Chemistry*.

## A nomenclature quiz

Can you determine the structure of these heteromonocyclic compounds for which systematic names are provided? Answers are shown toward the back of the magazine.

- (1) Oxirane
- (2) 1,3-Oxathiolane
- (3) 2H, 4H-1, 3-Dioxixine
- (4) 1,2-Dihydroazete



# Radiotracer studies clarify metabolism of nickel compounds

The radioactive isotope  $^{63}\text{Ni}$  is expected to gain wide use in biochemical and medical studies, as it is often the best—or only—way of exploring the role in nickel in the human body. That role is more prominent than was believed only a few years ago. Since then, it has been discovered that nickel is an essential trace nutrient for mammals, that nickel is an important component of at least one enzyme (urease), that some nickel compounds are associated with increased risk of cancer in nickel refinery workers, and that studies on the excretion of nickel could elucidate how the kidney functions.

Radioactive nickel isotopes allow researchers to study metabolism of nickel components in the bodies of test animals. Most nickel radioisotopes are not suitable for such studies: they are too short-lived, or do not have sufficient activity to be detected with high sensitivity. The ideal radioisotope for most studies is  $^{63}\text{Ni}$ . It has a long half-life (92 years), emits low-energy radiation, and is available with high activity. Beta radiation emitted by  $^{63}\text{Ni}$  is readily measured by standard liquid scintillation spectrometry techniques, but is completely absorbed by the walls of glass or plastic containers. Samples containing  $^{63}\text{Ni}$  do not constitute an external radiation hazard, but precautions must be taken by laboratory workers to avoid accidental ingestion or inhalation.

Various compounds and solutions of  $^{63}\text{Ni}$  are available for research studies from nuclear centers around the world. Other radioisotope compounds can be prepared in the researcher's laboratory by processing available  $^{63}\text{Ni}$  salts, or obtained from companies specializing in custom production of  $^{63}\text{Ni}$  compounds.

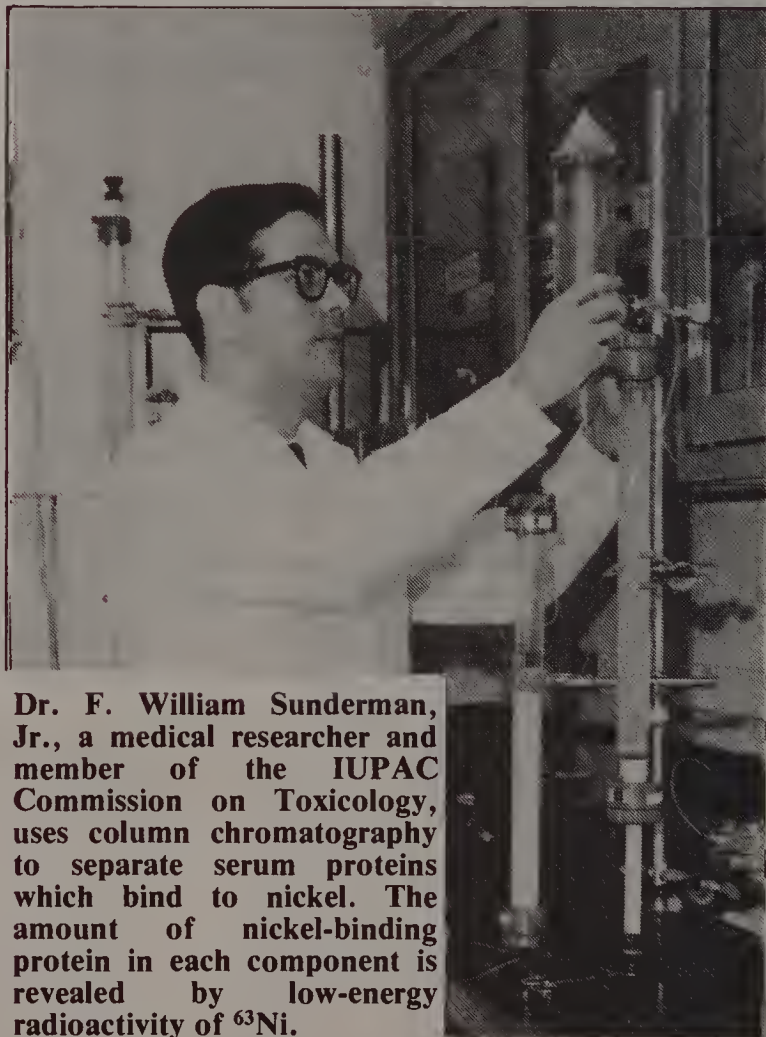
The metabolism of nickel in test animals depends markedly upon its chemical form.  $\text{Ni(II)}$  compounds, when ingested, remain largely unabsorbed from the digestive tract. A minor fraction is absorbed from the intestines. Once  $\text{Ni(II)}$  enters the bloodstream, it rapidly accumulates in the kidneys, lung, skin and some glands. It is excreted in the urine within 3-5 days after entering the bloodstream. Recent radioisotope studies show that  $^{63}\text{Ni}$  is transported in the blood bound to serum albumin, other proteins and amino acid ligands. The presence of nickel-binding macromolecules *within cells* has been suggested, but little is known of their identity or properties.

Metabolism of nickel carbonyl is of special significance. This compound is widely used in

commercial nickel purification, and is of great interest in biology and medical studies because of its extremely high toxicity, and its ability to cause tumors and induce birth defects. Nickel carbonyl,  $\text{Ni(CO)}_4$ , is highly volatile; its vapor is absorbed by the lungs, and exhaled in the breath. The compound is fat-soluble, so it can cross the blood-brain barrier and enter red blood cells, in which the compound slowly decomposes to carbon monoxide and  $\text{Ni(II)}$ .

Another compound, nickel subsulfide ( $\text{Ni}_3\text{S}_2$ ) is of special interest in cancer research because of its extraordinary carcinogenic potency. It is a naturally-occurring mineral, but is also formed during sintering of nickel-copper sulfidized ores, and is a constituent of many nickel catalysts and nickel alloy corrosion products.

Measurement of  $^{63}\text{Ni}$  in biological samples is generally done by liquid scintillation spectrometry, in which a photomultiplier detects the weak light flashes caused by impact of beta particles (fast electrons) on molecules in a specifically-chosen scintillation fluid. The method is simple, but care must be exercised to avoid erroneous results. Nickel is absorbed on



Dr. F. William Sunderman, Jr., a medical researcher and member of the IUPAC Commission on Toxicology, uses column chromatography to separate serum proteins which bind to nickel. The amount of nickel-binding protein in each component is revealed by low-energy radioactivity of  $^{63}\text{Ni}$ .



Lung

Kidney



Rib Cartilage

Forestomach

The role of nickel in the body depends very much upon the form in which it is ingested or inhaled. Organs in which nickel collects are shown in these spectacular whole-body autoradiograms of mice which had ingested or inhaled  $^{63}\text{Ni}$  compounds. Whole-body autoradiography is a most recent technique — and possibly the most powerful — for toxicology studies. Radioactivity from accumulated  $^{63}\text{Ni}$  is indicated by white areas on autoradiograms presented here.

Above, the autoradiogram shows accumulation of nickel in the kidney, lung, forestomach and rib cartilage of a mouse 24 hours after injection of  $^{63}\text{NiCl}_2$ . The head of the mouse is on the left.

After inhalation of  $^{63}\text{Ni}(\text{CO})_4$  by a mouse (shown in the autoradiogram below), nickel collects in the lung, brain, nasal passages, rib muscle, heart, diaphragm and ovary. Nickel carbonyl is of special interest as an industrial toxin: it is widely used in nickel refining, is extremely poisonous, and is a vapor under normal conditions.

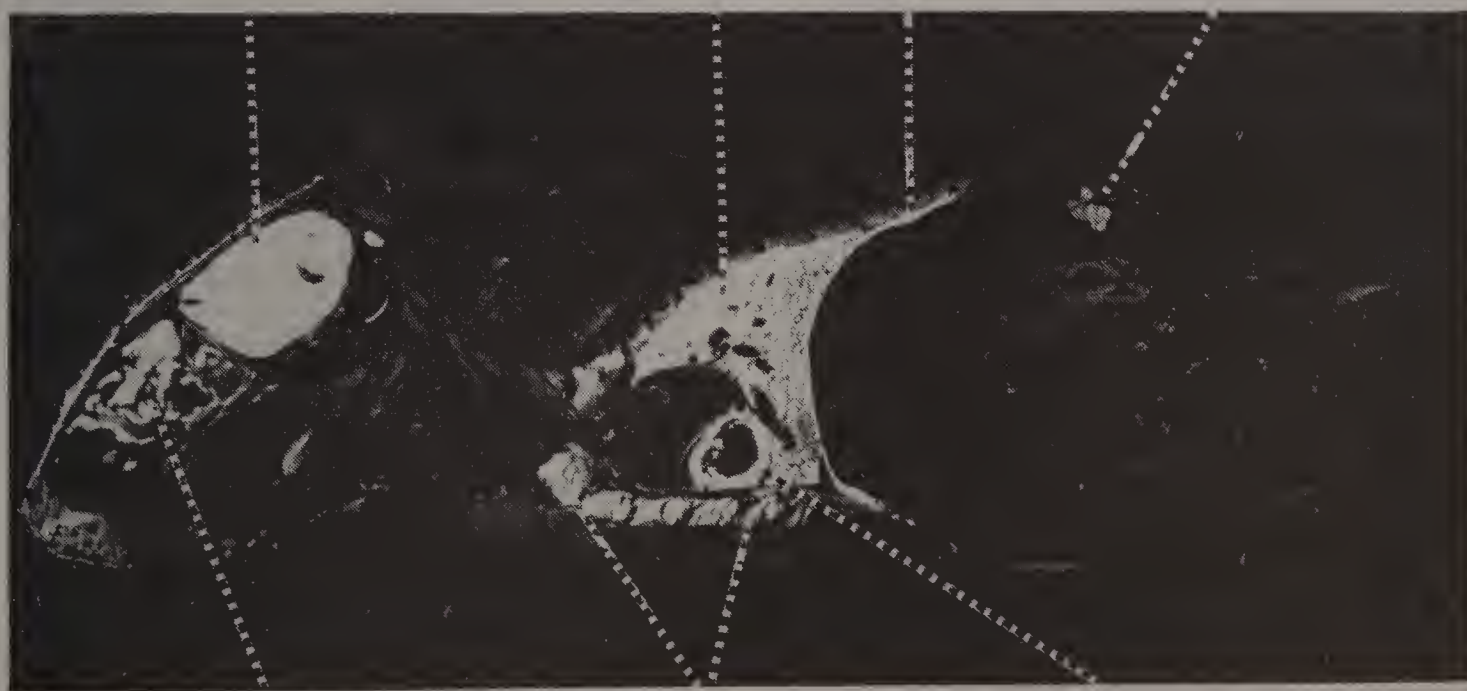
These autoradiograms provide a striking illustration of the potential of whole-body autoradiography and radioactive tracers for toxicology studies. They were provided by Drs. Agneta Oskarsson and H. Tjälve of the University of Uppsala Biomedical Center in Sweden, at the suggestion of Dr. Kazimierz Kaszrak.

Brain

Lung

Diaphragm

Ovary



Nasal Passages

Rib Muscle

Heart



glassware, so a non-radioactive nickel salt should routinely be added during the procedure to reduce nickel loss from the sample. Prior to the scintillation spectrometry measurement, sample solutions should be stored in vials made of plastic, rather than glass. It is necessary to store the vials in the dark for 24-28 hours before performing the measurement. This avoids interference by allowing a weak chemiluminescent glow to subside.

An alternative method, autoradiography, is useful for qualitative studies of  $^{63}\text{Ni}$  binding to proteins and amino acids. Nickel-containing complexes are first separated from other proteins on a thin-layer chromatography plate or electrophoresis strip. The plate is immediately dried, taken to a darkroom, and placed directly against the emulsion side of an x-ray film. The film and plate are wrapped in aluminium foil to provide a light-tight packet, which is stored for 15-90 days. During this period, the film is exposed to beta particles from those areas on the plate containing complexes of  $^{63}\text{Ni}$ . After exposure, the x-ray film is developed, and the pattern of spots is correlated against the original chromatography plate (or electrophoresis strip) which is stained so that protein or amino acid concentrations become visible.

A most recent development is histo-

autoradiography, which can show the distribution of  $^{63}\text{Ni}$  within a cross-section of the entire animal body. The amount of nickel within various organs and tissues of the body can be determined quantitatively or qualitatively by this method. This procedure, developed by Drs Agneta Oskarsson and Hans Tjälve at the University of Uppsala in Sweden, has been described in a published article only within the last few months.

Procedures for determining  $^{63}\text{Ni}$  in biological materials, safe handling of samples, and the wide range of nickel compounds used in radioisotope studies are discussed in the report *Radioactive  $^{63}\text{Ni}$  in Biological Research*, written for the IUPAC Commission on Toxicology. The report contains a concise summary of metabolic and toxicology studies performed to-date with radiolabelled nickel compounds used, animal species and type of sample tested, methods, and the most important observations.

The information was collected and discussed by Drs. Kazimierz S. Kasprzak (at the Radiochemical Laboratory of the Technical University of Poland) and F. William Sunderman, Jr. (Dept. of Laboratory Medicine of the University of Connecticut). The report appears in *Pure & Applied Chemistry*, Vol. 51, No. 6 (1979).

## Will protein derived from chemicals be the food of the future?

Single-cell protein, dried dead cells of microorganisms, was developed as a technological breakthrough intended to revolution food production. First generation technology for producing single-cell protein (SCP) from petroleum hydrocarbons has already been firmly established from engineering and product safety points of view. Yeast or bacteria are grown in a chemical broth containing hydrocarbons or methanol, forming a cell mass containing 45-50% protein. It is treated to remove nucleic acids and traces of the original feed chemicals, and then dried and granulated.

The potential advantage of food produced in this way are substantial. Large amounts of food could be "grown" in a plant occupying an area that is negligible compared to land required for producing the same amount of protein from crops or grazing animals. Food output is independent of climatic conditions.

SCP production *does* require hydrocarbons or alcohol as a feed material. These can be derived from a variety of energy sources:

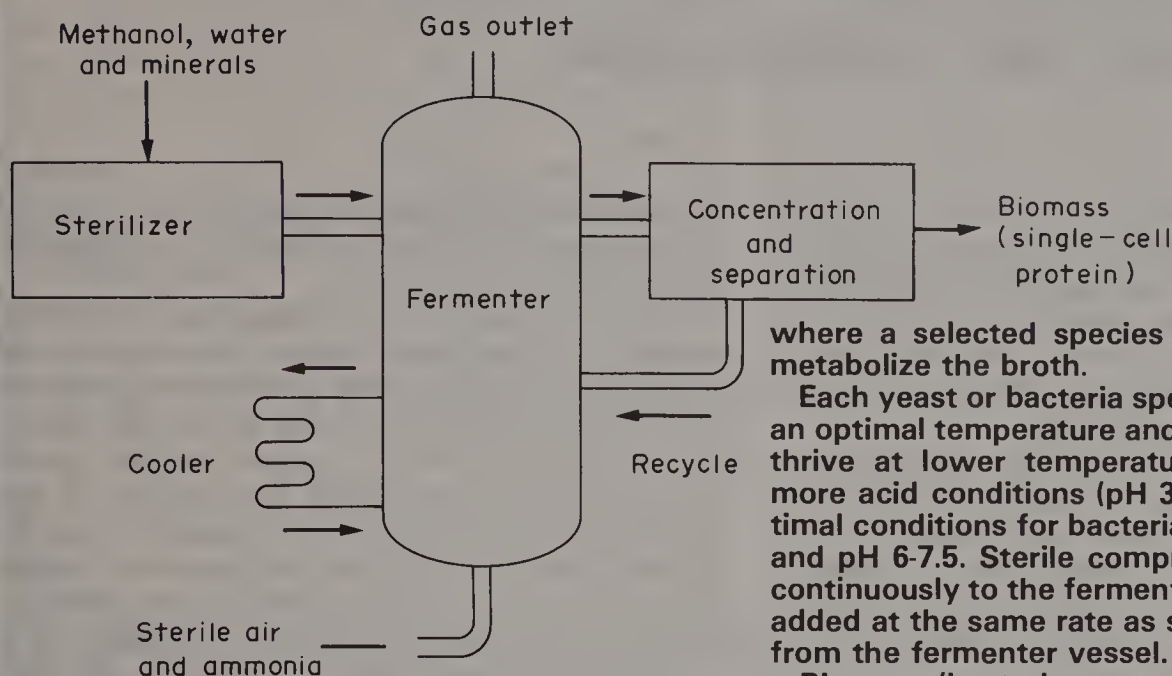
natural gas, petroleum or coal. The global shortage and uneven distribution of hydrocarbon fuels could be a major factor limiting the production of SCP, and determining in which areas it is made. But on the other hand, large amounts of hydrocarbons are used in conventional agriculture for harvesting, plowing, and producing nitrogenous fertilizer (which is absorbed by plants with low efficiency).

Methanol is a particularly attractive feed material, since it can be made from nearly any carbon source. A large number of naturally-occurring yeasts and bacteria are capable of growing on a methanol broth. Methanol is soluble in water, so the rate of microbial attack is not limited by diffusion into the aqueous broth, as it is with methane or other hydrocarbons. Methanol is available as a highly pure chemical of relatively low cost. Commercially-refined methanol contains only traces of impurities (mainly, lower alcohols) which would not adversely affect the safety of the SCP product.

It is well known that methanol itself is



## How synthetic protein is made from methanol



Methanol serves as the energy and carbon source for microbial growth in an aqueous broth. Ammonia (a nitrogen source), minerals and water are other essential ingredients. The broth is sterilized before it is introduced into a fermenter,

where a selected species of yeast or bacteria metabolize the broth.

Each yeast or bacteria species operates best at an optimal temperature and pH. Yeasts generally thrive at lower temperatures (27-30°C) and in more acid conditions (pH 3-5) than bacteria. Optimal conditions for bacterial growth are 35-43°C and pH 6-7.5. Sterile compressed air is supplied continuously to the fermenter. Fresh methanol is added at the same rate as solution is withdrawn from the fermenter vessel.

Biomass (bacteria or yeast cells) is separated from the culture and concentrated, while remaining solution is recycled after adjustment of its mineral composition and acidity. The wet biomass is usually spray-dried to a powdery SCP product. It may be pelletized for feeding to farm animals.

poisonous — indeed, fatal in large doses. But methanol is a natural product that occurs widely at low concentrations in edible fruits and vegetables, fruit juices and fermented beverages. Apples contain 25-60 ppm, tomatoes 180-200 ppm. Some alcoholic beverages have much higher methanol concentrations. US Brandies have been measured to contain 3700 ppm. Recommended standards for SCP require a residual methanol concentration of less than 20 ppm.

SCP is now produced in commercial quantities (by BP Liquichemica and ICI) and has been fed to one-quarter million animals. But the role envisioned for SCP as a protein source for much of the world's population is still very far off.

Of the barriers faced by proponents of SCP, none is more formidable than the requirement of assuring its absolute safety. Experience so far has shown that there is little biological hazard, but manufacturers will be required to establish that all their product is identical in every respect with sample demonstrated to be safe and nutritious in animal studies. Adequate evidence will need to be presented that the high-protein product does not contain toxic compounds produced by the micro-organisms, or introduced as a feed material. Before SCP can gain wider confidence, the industry must establish standards for purity and nutritional content, and demonstrate that it can maintain these standards with existing testing methods.

The most recent standards and testing procedures are outlined in the report *Proposed Guidelines for the Testing of Single Cell Protein as Protein Source for Animal Feeds*, prepared by the IUPAC Commission on Food Contaminants with the Commission on Fermentation. That report is in the final stages of preparation and will be published shortly in *Pure & Applied Chemistry*.

Why has SCP progressed so little, despite its substantial potential advantages? There is no scientific logic behind the delay, believes Dr. D. A. Stringer of ICI's agricultural research unit in the UK, a consultant to the Working Group which prepared the report. The situation results from a complex and (for SCP producers) frustrating combination of factors, including local and state legislation, extensive toxicological testing, lack of capital investment, and competition with other protein sources.

As far as SCP for human consumption is concerned, this is even more contentious than application as an animal feedstuff. Technological barriers of removing nucleic acids or potentially harmful compounds are relatively easy to overcome, compared with achieving a texture and flavour satisfactory to consumers. As Dr. Stringer points out, "The soya bean industry cannot claim success (in providing high-protein food for people). Is it therefore realistic to even suggest that SCP's should have reached this stage of product development".

# A promising new technique can analyze and separate dust components

Airborne particles can be analyzed—or separated—according to their mass, electrical charge and chemical composition using a new spectroscopic method. Direct applications could follow in air pollution studies, investigations of gas-solid surface reactions, color photocopying, and chemical purification.

The technique, photophoretic spectroscopy, is an elaboration on the classic Millikan oil-drop experiment for measuring the charge of an electron (performed in 1909). Like the Millikan experiment, the new technique suspends a charged particle in the electric field between two metal plates. The weight of the particle is kept in balance by the upward force of the electric field. But photophoretic spectroscopy incorporates several major innovations. Firstly, the particle's exact position is monitored automatically. A narrow beam from a helium-neon laser strikes the particle and is scattered through focussing lenses onto two photomultipliers, whose output is analyzed electronically to determine the height of the particle. If it rises or falls, the voltage applied to the electrode is automatically adjusted to return the particle to its original position. Sideways motion of the particle is prevented by a horizontal electric focussing field.

The second main addition to Millikan's experiment is an ultraviolet light beam incident on the particle. This causes electrons to be photoejected from the particle's surface (one about every 15 seconds). The change in electric field necessary to balance loss of each photoelectron

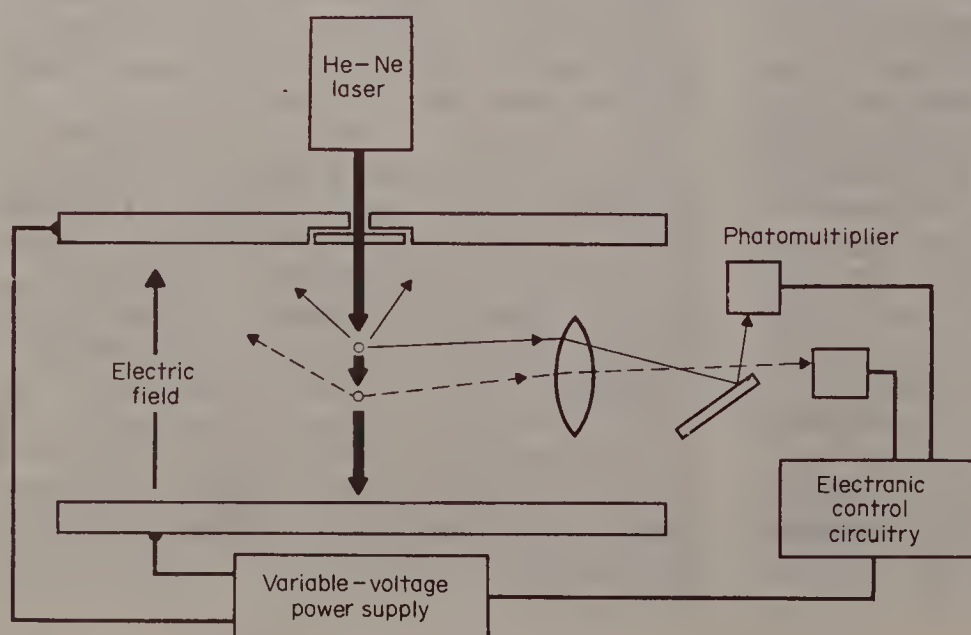
is measured, and from this data, one can readily determine the absolute charge and mass of the particle.

The composition of the particle can be determined by an ingenious indirect measurement of the particle's absorption of visible and ultraviolet light. For this, a source of variable wavelength radiation is used, rather than an ultraviolet source of one fixed wavelength. If the wavelength of the incident radiation is absorbed by the particle, local heating causes a change in the apparent weight of the particle. Depending upon the gas pressure and direction from which the incident radiation strikes the particle, it will tend to either float upwards or sink. This change in apparent weight is detected by the monitoring system, which changes the voltage applied to the electrode plates so as to maintain the particle at the same position. The change in balancing voltage varies with the amount of incident light absorbed by the surface of the particle. By varying the wavelength of the incident radiation, an absorption spectrum of the particle surface is recorded.

Photophoretic spectroscopy is similar to another method of measuring absorption spectra based upon heating effects of absorbed light, photoacoustic spectroscopy. That technique has proven itself well-suited for measuring absorption spectra of opaque surfaces. Monochromatic light incident on the sample is chopped at high-frequency so that pulsed heating of the illuminated surface generates pressure waves—that is, sound—in the sur-

One major innovation that allows spectroscopic analysis of micron-size particles is an automatic feed-back system for monitoring and adjusting the height of one charged particle. Absorption of incident ultraviolet radiation (not

shown) changes the apparent weight of the particle, causing it to drift up or down. This is detected by scattering of a monitoring light beam into two photomultipliers. An electronic control circuit analyzes the relative signal of the photomultipliers, and adjusts the voltage applied across the electrodes so that the particle returns to its original position. The voltage required to maintain the particle steady indicates how strongly it absorbs the incident u.v. radiation. A more complete discussion of the experimental apparatus is found in *Journal of Aerosol Science*, 10 (1979) p. 49.





rounding air. But photoacoustic spectroscopy cannot be used to examine microscopic particles like photophoretic spectroscopy can. Developers of the photophoretic technique, Drs. Martin Pope and Leonard Rozenshtein of New York University and Dr. Stephen Arnold of Polytechnic Institute of New York, have found that their experimental apparatus operated well with particles 0.4-10 mm diameter, detecting particle weight changes equivalent to a fraction of a picogram.

Photophoretic spectroscopy also has the potential to separate particles of different

chemical composition, as well as analyzing them. A mixture of particles with the same mass/charge ratio can be suspended in an electric field and subjected to radiation of a chosen wavelength. Absorbing particles will rise or fall (depending upon conditions), forming a horizontal layer apart from the main particle layer. Blowing these through a slot would remove them from other particles. It could ultimately prove possible to use the photophoretic effect as a general purification technique for solids.

## A global resource could yield energy, but is now discarded into the sea

What happens when you mix ocean saltwater with freshwater effluent? Probably nothing, except forming a solution of intermediate salinity. But what you *could* get is energy. What's needed is an osmosis or a reverse electrodialysis cell to extract the inherent "entropy of mixing" of the two solutions. Presently, enormous amounts of water drain into the oceans and mix spontaneously with seawater. Energy of mixing is not recovered, but simply dissipated, as would be heat energy without a boiler and engine.

Very large amounts of electric power could be produced by utilizing the concentration difference between rainwater drainage (carried by rivers) and seawater. This possibility, first proposed in the early 1950's, is now being considered seriously for the first time. New membrane technology that would allow such energy production has, so far, been applied on a large scale for the reverse process — separating salts or fresh water from solution.

That *requires* energy. Indeed, there is a minimum energy that must be expended to separate the components of a solution. By putting energy into the process, osmosis cells are used to desalinate seawater, or recover metal ions from electroplating waste solution. In Japan, electrodialysis is used to concentrate seawater for the production of salt. A similar process removes salts from brackish well-water in Western Canada.

The same membrane technology can *produce* mechanical energy by pressure-retarded osmosis, or electrical energy by reverse electrodialysis. These processes operate by recovering the mixing energy of two feedstreams; a

concentrated salt solution (seawater or brine), and water with low salt content.

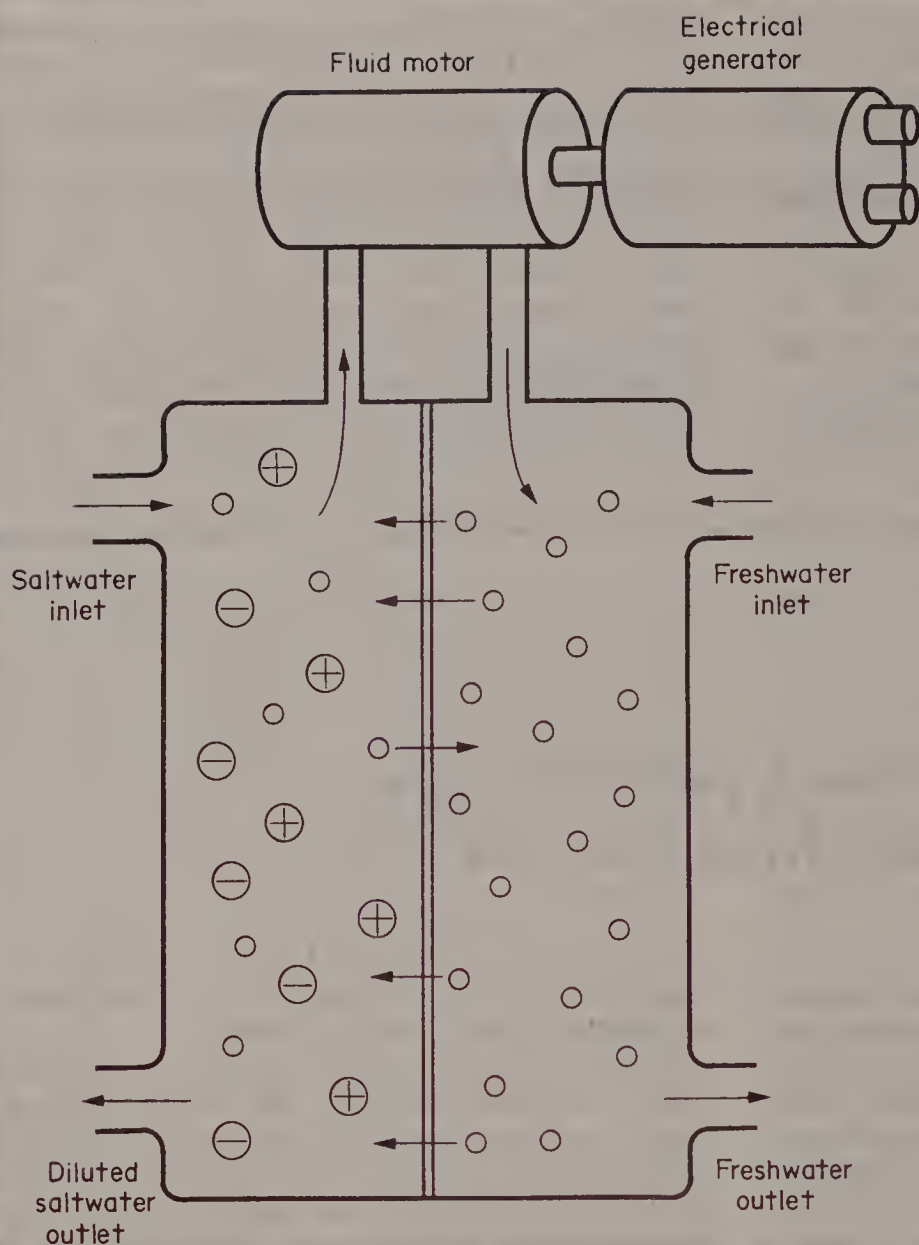
In a pressure-retarded osmosis cell, a membrane separates the two feedstreams. Membrane pores selectively allow water molecules to diffuse across to the solution on the other side, while blocking the passage of ions. Migration of water molecules from the dilute solution to the concentrated salt solution creates a pressure difference across the membrane. Fresh water continues to diffuse through the membrane, despite the high pressure which develops on the concentrated salt solution. Mechanical power is produced when the pressurized salt solution flows through a fluid motor into the dilute solution. During the production of mechanical power, the solutions become mixed and must be replenished by a steady flow of fresh feed solutions.

A reverse electrodialysis cell uses two membranes — one which selectively allows anions to pass through its pores, the other which allows cations to pass. Diffusion of ions — from concentrated to the dilute solution — creates an electrical potential difference.

The Free Energy which can be liberated by mixing fresh water with the same volume of seawater is theoretically 0.44 kWh per cubic metre, which is equivalent to the energy dissipated by the water falling 160 metres in height. That is nearly three times the height of Niagara Falls, and probably higher than the elevation used by any hydroelectric generating station.

Enormous amounts of energy could potentially be generated where riverwater flows into the ocean (seawater has a salt concentration of



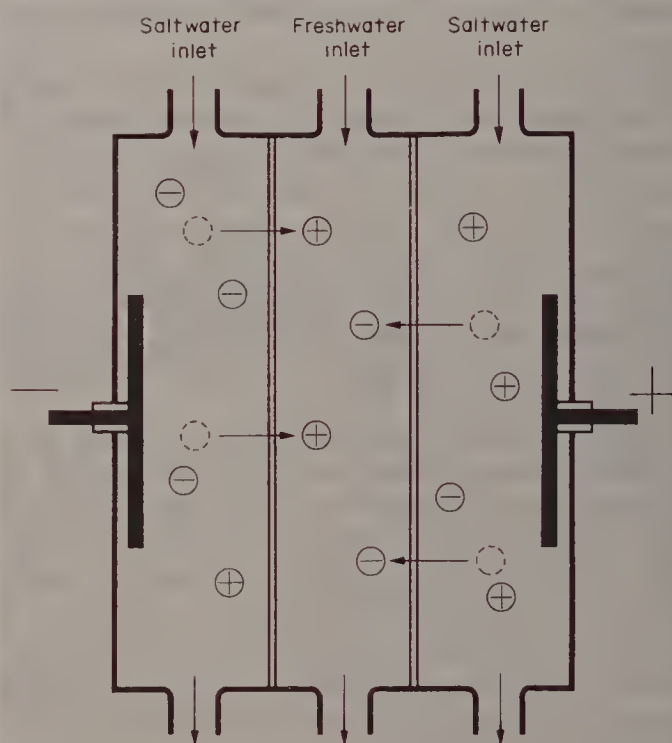


A pressure-retarded osmotic cell develops power by utilizing pressure which develops across a semi-permeable membrane. Water molecules, but not ions, diffuse freely across the membrane in both directions, but the higher mole fraction of water in the dilute solution causes a net migration into the concentrated solution. The osmotic pressure between seawater and freshwater can reach a maximum of about 15 atmospheres . . . enough pressure to force the seawater to a height of 160 metres, or through a fluid motor.

If an external pressure greater than 15 atmospheres is applied, reverse osmosis occurs. Then, rather than the solutions mixing, fresh water is produced by a net diffusion of water molecules from the seawater across the membrane. Ions are effectively filtered from the seawater, from which the term "ultrafiltration" is derived for reverse osmosis.

about 0.5M) Each cubic metre of fresh water flowing each second into the ocean could provide 30kW of electrical power (assuming that the osmosis or electrodialysis process is only 20% efficient). Ten times greater power could be generated from the same flow of concentrated brine being discharged into fresh water. The cost of electrical power produced in this way is estimated at about US\$100/MWh for a plant mixing river water with seawater, and US\$20-30/MWh for a plant powered by brine water.

How much power could be harnessed by mixing river and sea water? That depends upon how much fresh and salt water are available to be mixed. Countries with substantial rainfall and an ocean coastline could obtain maximum benefit. The potential for power generation in Canada was considered by an article in the May issue of *Chemistry in Canada*. The authors, Drs. C. Forgacs (on leave in Canada from Ben Gurion University in Israel) and R. N. O'Brien (of the Univ. of Victoria in British Columbia, Canada), suggest that 3500 MW electrical power could be produced if only 10% of the total drainage in Canada is used for reverse osmosis or reverse dialysis power production. That is equivalent to the power output of five nuclear reactors of recent Canadian design. That would be a small — but significant — contribution towards solving future energy problems in Canada.



Reverse electrodialysis produces electricity directly from the mixing energy of concentrated and dilute salt solutions. The cell contains both an anion-exchange membrane (through which only negative ions can diffuse) and a cation-exchange membrane (through which positive ions diffuse).



# Upgrading waste to high-grade fuel entices developers of biogas

Animal manure, sewage and some industrial wastes can be chemically upgraded into a clean, combustible fuel — biogas. Technology is at hand to produce biogas as a natural gas substitute for heating, lighting, powering engines and gas turbines. No doubt, production of biogas will be further enhanced by refinements in technology and economies of large-scale generating plants.

Unlike some proponents have suggested, biogas *cannot* provide a major share of the world's energy requirements. But it *could* make a significant contribution as a hydrocarbon resource and serve as an important intermediate in waste recovery and recycling systems.

by Dr. Martin Gellender  
Editor

Biogas production utilizes cellulose, carbohydrates and other organic content in human sewage, animal manure, or industrial effluent from processing of meat, yeast, cornstarch and distillery grain. Treatment of these wastes by bacteria, in the absence of air, produces a gas mixture containing about 65% methane and 35% carbon dioxide. Biogas has somewhat less heating value than the same volume of natural gas (nearly 100% methane), but provides 30% more heat than synthetic fuel gas made from coal. Technology for biogas production is already well established, although it is likely that present research efforts will increase its efficiency, speed and economics.

The amount of energy that can be produced from farm waste and human sewage is not impressive when compared against present consumption of non-renewable oil and natural gas. A biogas generator operating on waste from 1000 pigs, for example, could yield a steady biogas output with only 40 kW heating value. From that, perhaps 12 kW electricity could be generated (with waste heat used to keep the biogas digester at operating temperature). That would probably be enough to provide the energy requirements of the farm, with little or no surplus. But generating this amount of biogas would avoid the need to consume 30 litres of heating oil per day, or the burning of 100 kg of coal for generating electricity.

Production of biogas would certainly be worthwhile for those industries able to collect organic waste, and utilize (or sell) the product gas. The reduction of petroleum imports could be very substantial in developing countries, and significant in industrialized nations. One analysis of potential biogas production in Britain (*Methane: Planning a*

*Digester*, by Peter-John Meynell, Prism Press, 1976) estimates that a total annual biogas production of 1.7 billion cubic metres (equivalent to the energy in 5 million barrels of crude oil) could be achieved with wastes already collected, treated or discarded. This could replace about 3% of the natural gas presently consumed in Britain, or about 0.4% of total energy requirements.

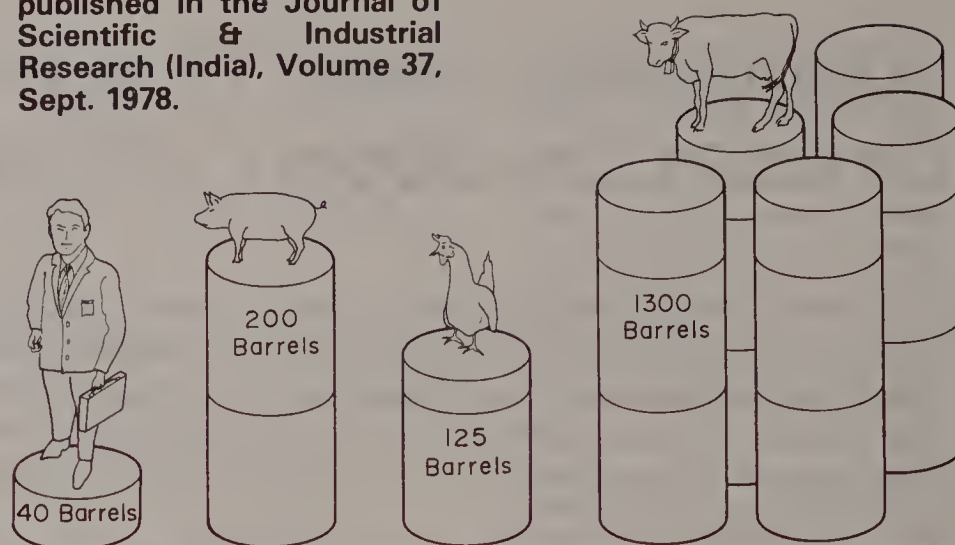
Perhaps that may not seem significant, but biogas production cannot be viewed simply as an energy source. Rather, it is part of an integrated system of energy production, nutrient recycling and pollution control. Byproduct sludge generated by the process is an excellent fertilizer and soil conditioner. It possesses little of the odor or objectionable properties of raw feed material. Well-digested sludge retains all nutrients in the original feed. In fact, breakdown of proteins during anaerobic digestion liberates nitrogen in a form readily utilized by plants. At least half the nitrogen present in the original sewage or waste (bound in proteins, and not readily assimilated by plants) is converted to dissolved ammonia. The byproduct sludge can displace much of the synthetic nitrogen, phosphate and potash fertilizer that could otherwise be necessary. Reduced consumption of nitrogen fertilizer is especially important, as its manufacture is a highly energy-intensive process.

Biogas generation will probably be widely applied in developing countries. There, shortages of firewood and other fuels has forced villagers to burn dried cattle dung, rather than using it for fertilizer. The result has been deterioration and erosion of the soil, and expansion of desert into previously fertile borderline areas. Introduction of biogas technology could reverse this destructive trend. India has already established a program to build 100,000 family-size gas plants each year, for 10 years. Each gas generator will cost US\$200-400. The next step will be design



Methane gas produced from human sewage and animal dung can provide a significant amount of energy, although much less than presently is used in industrialized countries. Shown here is the equivalent energy production (barrels of crude oil) that could be produced each year by treating sewage from 1000 people, and manure from 1000 pigs, 10,000 poultry, and 1000 Third World Cattle. Data for this table was derived from *A Status report on the Use of Biogas Technology for Increasing Fuel and Soil Productivity*, published in the *Journal of Scientific & Industrial Research (India)*, Volume 37, Sept. 1978.

*ing Fuel and Soil Productivity*, published in the *Journal of Scientific & Industrial Research (India)*, Volume 37, Sept. 1978.



and construction of larger units able to provide fuel, fertilizer, irrigation power and sanitation facilities for an entire village. A village-size biogas cooperative could, according to one estimate, pay back its cost of construction within 5 years. It would help ensure that benefits of biogas technology are available to poor villagers, as well as those with land and cattle. Just as important, major technological advantages would be achieved by operating large biogas systems serving an entire community.

Until now, biogas has generally been produced in small generators. One type (used in India) utilizes manure of three cattle and produces 3.5 cubic meters of biogas per day (equivalent to the energy content of 2 litres of heating oil). Such units require considerable time and attention, considering the relatively small output of fuel gas. Substantial economies of scale and more efficient use of accessory equipment and labor are achieved in larger units. Large digestors are also less susceptible to rapid changes in temperature, pH, and composition of the feed material. Daily temperature variations of 1°C, to which small biogas generators are susceptible, cause a decline in gas production.

Methane-producing bacteria will function at any temperature between 5° and 55°C, although the rate of gas generation is highly dependent upon temperature. Gas production is much more rapid at higher temperatures, except for a distinct drop in gas production at about 40°C. This temperature is not favorable for either of the two types of methane-generating bacteria: those that function best above 40°C (thermophilic bacteria), or bacteria best suited for lower-temperature methane production (mesophilic). Gas production is fastest and greatest when carried out at 40-55°C, but few digestors operate in this range. Usually, energy required to maintain the digester at elevated temperatures more than outweighs increased gas production. But this will probably not always be true, especially for larger, more advanced digestors. In fact, the largest digestion plant that has been built, the recently-completed Experimental Anaerobic Fermentation Facility in Bartow, Florida (USA), will operate with thermophilic bacteria. It will digest 25 tons (dry weight) manure per day at about 55°C. This high operating temperature will reduce retention time of

waste in the digester to about 10 days. By comparison, conventional digestors are usually designed to retain waste for 15-30 days at an operating temperature of 30-35°C. The time that waste is retained in the digester is always a compromise: more gas is generated if the waste is retained longer, but then a larger digester is needed to compensate for slower evolution of methane in the final stages of anaerobic digestion.

In addition to better temperature regulation in a large biogas generator, the composition of feed material can be more carefully monitored and controlled.

Methanogenic bacteria have fairly simple nutritional requirements, but will function poorly or die if these needs are not met. The inherent sensitivity of these bacteria stems largely from the little energy that can be derived by anaerobic digestion, but which the bacteria must use to live and grow. Most of the energy in the feed material is discarded by the bacteria in the energy-rich product, methane. But the frugal lifestyle of anaerobic bacteria has its drawbacks. The bacteria grow and multiply slowly, cannot utilize oxygen and die in its presence. They are sensitive to antibiotics, disinfectants, detergents and pesticides. Sudden introduction of small amounts of these compounds into the digester (perhaps after washing farm buildings or processing equipment) can easily kill the bacteria in a small digester with insufficient volume to dilute an influx of toxic material.

The most important nutritional need of methanogenic bacteria is a source of carbon, which also serves as an energy source. Cellulose is the preferred material. It is easily digested, except when it is combined with lignin (the material forming the rigid woody structure of plants). Plant material is far more readily digested if it is first broken down, both physically and chemically. This preliminary processing is most conveniently carried out in the digestive system of an animal.

Apart from carbon, the nitrogen content of the waste is important. If too little nitrogen is present, bacteria will be inefficient in breaking down the organic matter. Too much nitrogen in the feed material can cause so much ammonia to be produced that the solution becomes alkaline, and bacterial



growth is inhibited.

Phosphorus and sulfur are other nutrients required by bacteria, although most wastes have sufficient amounts to satisfy the needs of bacteria. However, too high a sulfur content causes corrosive hydrogen sulfide to appear in the biogas product. Trace quantities of calcium, magnesium, potassium, zinc and iron are also needed, but these too are generally present in adequate amounts.

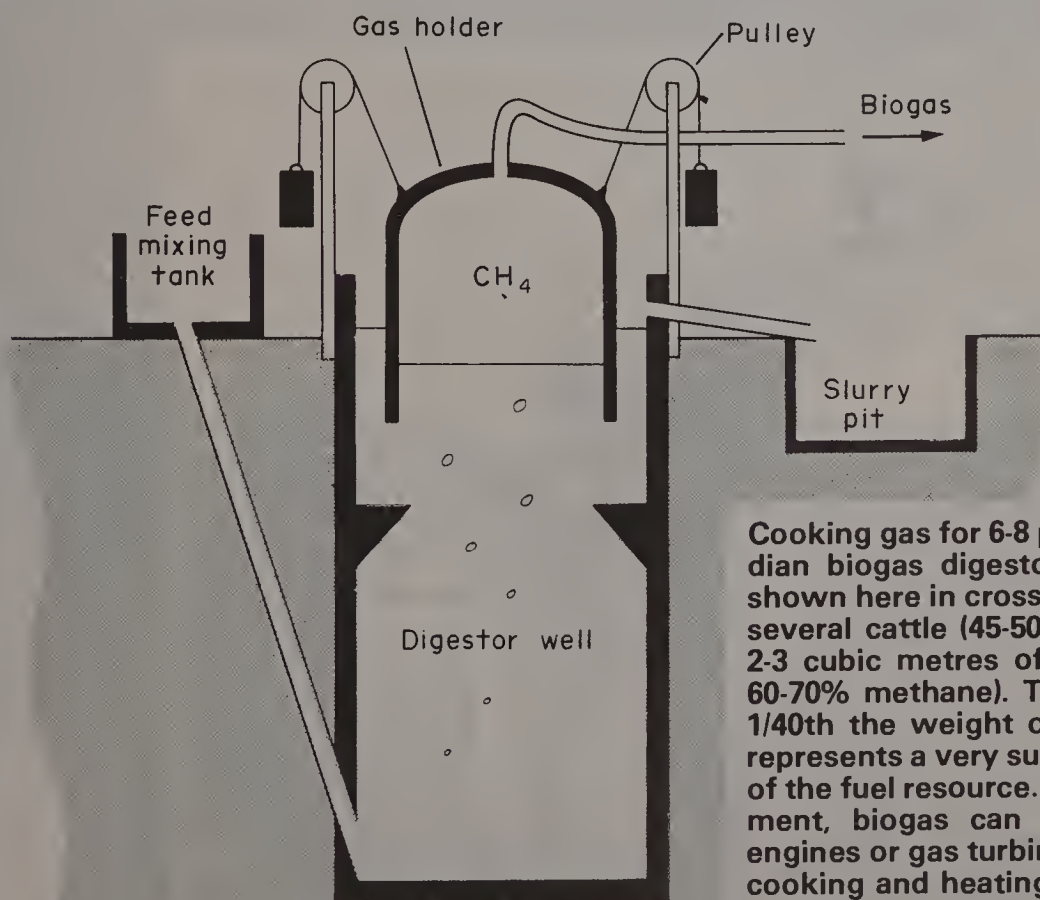
The concentrations of nutrients, bacteria and the solution pH are inter-related, and change as digestion progresses. Anaerobic digestion is not one continuous process, but occurs in two stages, each undertaken by a different kind of bacteria. The two stages are consecutive, but occur simultaneously as fresh waste is introduced and product gases are withdrawn. Initially, non-methanogenic bacteria decompose carbohydrates, proteins and fats. Metabolic end-products of these so-called "acid-forming" bacteria are acetic, propionic and butyric acids. As proteins and amino acids are broken down, their nitrogen content is liberated as ammonium salts. All these products will serve as food for methane-producing bacteria in the second stage of biogas generation. A diverse variety of bacteria participate in the acid-forming stage. Some are able to function in the presence of oxygen. Generally, acid-forming bacteria grow rapidly, and can tolerate sudden changes in their environment.

In sharp contrast to the acid-formers, methanogenic bacteria are fastidious in their requirements for survival and growth. Their slow growth and metabolism generally limit the rate of biogas production. They rely on acid-forming bacteria to provide all their nutrients, and to purge oxygen remaining in the digester. Acetic acid is their

most important food (about 70% of the methane product is derived from acetate), but carbon dioxide and hydrogen are also metabolised. Their nitrogen requirements are satisfied by ammonium salts produced by acid-forming bacteria: they are incapable of utilizing any other source of nitrogen.

The relationship between the two types of bacteria is not uni-directional. Consumption of acetic acid by methanogenic bacteria prevents the solution from becoming too acid. Only because methanogenic bacteria convert organic acids into gases (methane and carbon dioxide) can acid-forming bacteria continue to function. Indeed, excessive acidity can be corrected by stopping the introduction of fresh waste. This allows methanogenic bacteria to "catch up" with acid-forming bacteria, and reduce the concentration of organic acids. Thus, the two kinds of bacteria are inter-dependent. Acting together, they maintain the acidity within the correct range (pH 7-8) for both acid-forming digestion and methane production. In a working digester, the bacterial populations balance so as to provide each others needs.

Because of the complex inter-relationship between the different bacteria, it has been difficult to study metabolic processes occurring in an operating digester. Much experimental work is presently being carried out to study optimal conditions for high-rate digestion of agricultural and industrial wastes. These studies, undertaken by universities, commercial companies and enthusiastic individuals, are aimed at improving the economic and commercial viability of biogas generation. A few studies utilize artificially-simulated dung so that composition of the feed material can be carefully controlled. Other experimental digestors are designed for maximum



Cooking gas for 6-8 persons is produced by an Indian biogas digester whose main features are shown here in cross-section. Fed with dung from several cattle (45-50 kg/day), the digester yields 2-3 cubic metres of biogas per day (containing 60-70% methane). The yield of methane is only 1/40th the weight of the "raw material", but it represents a very substantial upgrading in quality of the fuel resource. With little or no further treatment, biogas can power internal combustion engines or gas turbines, as well as being used for cooking and heating.

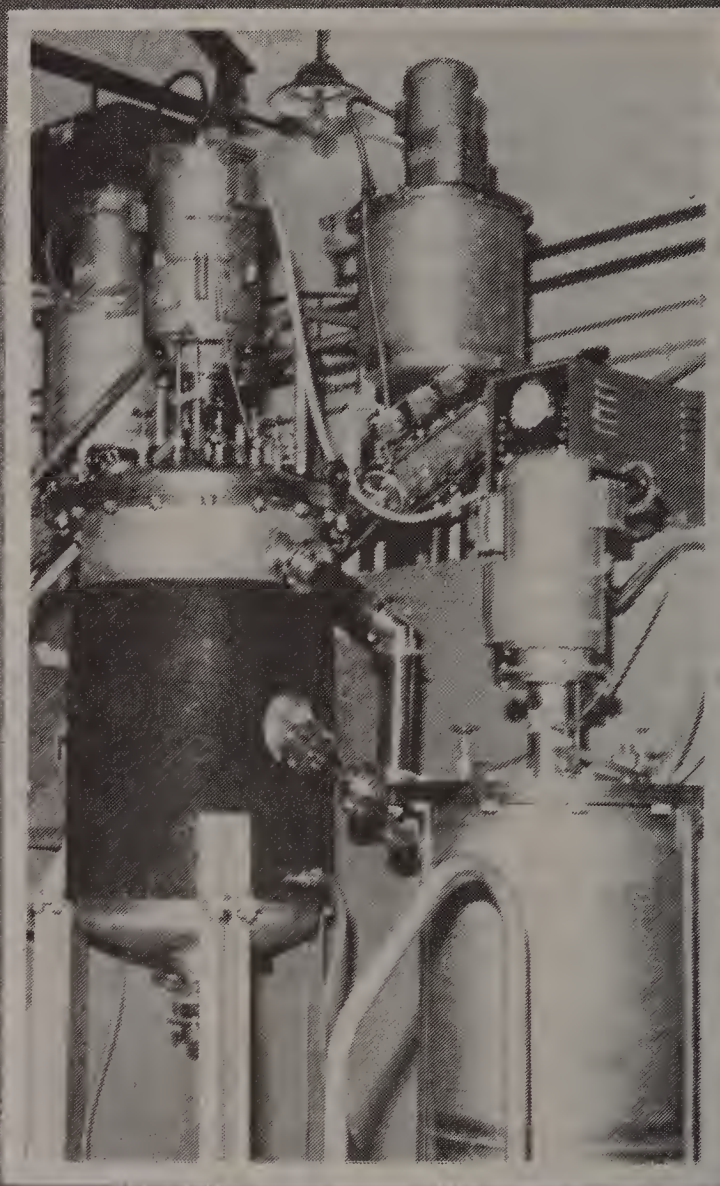
Biogas is not the only valuable product of anaerobic digestion. Equally important is the sludge produced, which is excellent fertilizer. It contains all the nitrogen, phosphorus and potash present in the original feed material, in a form more readily absorbed by plants.



Biogas is generated from various types of agricultural waste in this pilot plant (right). It is used to study the effects of variations in feed, temperature and other factors affecting the rate of anaerobic digestion. At the left of this photograph is a 150 litre digester. Feed tanks and pumps are in the background (top of photo). On the right is an overflow collection tank, temperature regulator and methane withdrawal lines.

Pilot-plant results are tested in a larger field-scale unit shown below. A 13,500 litre upright cylindrical digester, with a stirrer motor visible on top, has been operating with piggery waste for the last 6-7 years, but is now being changed to cattle waste. A second digester of the same size (in background) is testing the efficiency of gas stirring, liquid-flow stirring, and an input-output heat exchanger. The two buildings house boilers, pumps, recording apparatus and other ancillary equipment.

Experiments on the pilot-plant and field-scale unit are carried out jointly by the Rowett Research Institute and the Engineering Division of North of Scotland College of Agriculture (both in Aberdeen, Scotland), who provided these photographs.





flexibility of operating conditions, and allow feeding rates, degree of mixing, gas circulation, temperature, organic content and retention time to be varied independently.

One of the major programs aimed at developing practical commercial units is that the Rowett Research Institute and North of Scotland College of Agriculture (in Aberdeen, Scotland). They have built and operated a high-rate farm-scale digester (with capacity to digest waste of 300 pigs). A simpler unit, three times the size, is estimated to cost about US\$25,000. Several other groups are involved with designing and building practical digester units. Among these are the Gobar Gas Institute in India, and T. H. Hutchinson Co. in Kenya.

It would be misleading to believe that biogas production will be practical only in the developing nations. True, the most extensive use of biogas has been India (the Indian Agricultural Research Institute developed the first "Gobar" gas plant in 1939). However, during the second world war, many farmers in England, France and Germany built small

digestors to produce methane from their farm wastes. Presently, many large sewage treatment works provide all their own energy needs (for pumping and aeration) by generating methane. Anaerobic digestion is also being developed as a means of treating petrochemical wastes. In a process developed by Celanese Corporation in the US, Chemical Oxygen Demand (COD) of petrochemical waste is reduced 60%, while biogas provides process heating requirements (reported in *Chemical & Engineering News*, May 14th issue, 1979, p.7). And the General Electric Corporation is reported to have developed a membrane unit to separate methane from biogas produced at sewage treatment plants (*Chem. & Eng. News*, May 21st issue, 1979, p. 13). Pure methane, isolated from surplus biogas, could be more economically piped from sewage treatment plants, and made available for industrial and domestic energy users. It would be an important link in recycling biogas energy to the homes, farms and industries that provided the low-grade energy resource.

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# Nuclear fusion research poses challenges for chemists

A few years ago, it was thought unlikely that plasmas of deuterium and tritium ions could be contained hot enough and long enough for the nuclei to fuse. At temperatures above 100 million °K, the nuclei have sufficient velocity to overcome their electrostatic repulsion. They collide, fuse into helium, produce a neutron, and liberate nuclear binding energy. The reaction, which occurs uncontrolled in the Hydrogen Bomb, produces an enormous amount of energy. It now appears nearly certain that nuclear fusion can be controlled inside a reactor, and that commercial fusion reactors will be operating in the 21st century.

In the long-term, nuclear fusion could provide almost unlimited energy. With earth-bound fuel resources, fusion could supply twenty times as much energy as initial recoverable supplies of oil and coal.

The control of nuclear fusion will be a technological achievement unparalleled in history, and the greatest triumph of nuclear physics. But what contribution will **chemists** make to the fusion research program — a program that may be the largest scientific development of the 20th century, that will require an international effort lasting over 20 years, and that perhaps, will be the most significant event of our lifetime.

by Dr. Martin Gellender  
Editor

Despite enormous strides that have been made recently in fusion research, awesome challenges remain. Deuterium-tritium plasmas have been heated to 70 million °K, contained by magnetic fields for up to one second, and significant numbers of fusion reactions have been observed. It is now generally believed that no fundamental obstacles remain in the way to break-even conditions: where more energy is produced from fusion than is required to heat and confine the plasma.

What remains to be achieved is plasma temperatures above 100 million °K, and a plasma density (or confinement time) ten times greater than is achieved in current experiments. These requirements are not as impossible as may appear. Ion densities, plasma temperatures and confinement times achieved in fusion experiments have increased rapidly and steadily since fusion research began in the 1950's. Only 25 years ago, plasma physicists could attain plasma temperatures of a "mere" 100,000°K, and could confine plasma for only 1/10,000 second. To bridge the gap to an energy-producing fusion reactor requires only a continuation of the steady progress already made.

But as experimental fusion devices get larger and larger, the next few steps will become increasingly costly. To bring fusion to the level of a practical energy source will require perhaps the largest research and development of the 20th century (estimated cost to all participating nations has been estimated at US\$50. billion).

Once fusion reactors can be made which produce a

net energy output — probably in the mid-1980's — the potential for commercial application will be enormous. The total fuel supply is limited only by the amount of tritium that can be produced in the reactor (by irradiation of lithium with neutrons produced by the fusion reaction). Total energy production could be 11,000 Terawatt-years, enough to provide the world's present energy demands for over one thousand years. It seems highly plausible that 10,000 fusion reactors might be built during the 21st century, providing half the global demand for electric power. Preliminary studies suggest that fusion reactors would be inherently less prone to serious accidents than conventional nuclear (fission) reactors or fast-breeder fission reactors. It also appears that fusion reactors would generate smaller amounts of hazardous long-lived isotopes. The waste would not need to be transported to reprocessing plants (a major drawback of a fast-breeder nuclear program).

The spectacular advances in plasma physics which have propelled nuclear fusion research to the threshold of practical useage have exposed the inadequacies of materials and treatment methods now available for the construction of fusion reactors. Materials used in conventional nuclear reactors will not tolerate the entirely different, and very formidable, radiation and chemical environments in nuclear fusion reactors.

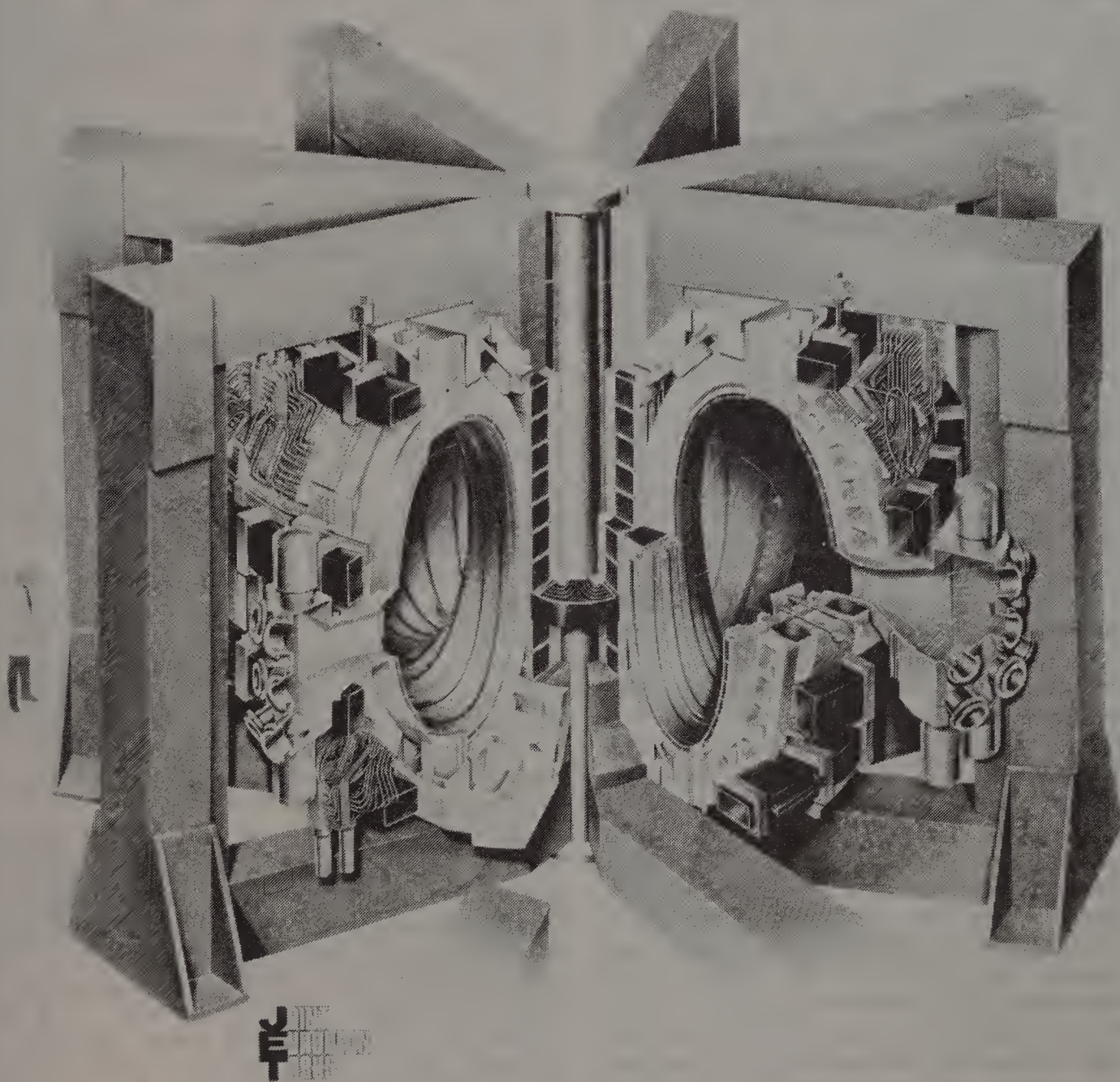
Development of new materials and methods will be a major effort directed at two fronts. Two completely different methods of achieving controlled nuclear fusion are competing for superiority in the development race, and each will require its own unique approach.



# The original concept: hydrogen plasmas trapped by magnetism

The area of fusion research which first attracted serious attention was the confinement of plasma by powerful magnetic fields. Devices were developed utilizing the well-known forces of interaction between charged particles (high-velocity ions and free electrons within the plasma) and a magnetic field. Most successful of the various types of magnetic

confinement devices has been the TOKAMAC. The basic design employs a toroidal magnetic field, a configuration developed during the 1950's in the USSR (the word *TOKAMAC* is derived from the Russian for "toroidal magnetic chamber"). The TOKAMAC design has exhibited remarkable progress, and progressively better results have been



TOKAMAC-type fusion devices utilize strong magnetic fields to confine a dense plasma within a toroidal vacuum chamber, and prevent contact with the vessel wall. The Joint European Torus (JET, depicted here in cross-section) is the largest now under construction. In the JET apparatus, the fusion reaction will produce less energy than the electrical power needed to operate the electromagnets and heat the plasma. But the experimental JET TOKAMAC will provide essential operating data for the next generation of fusion reactors, capable of net power pro-

duction.

The major radius of the toroidal vessel in the JET apparatus is 3.0 metres, about 3-4 times larger than most of the 15-or-so TOKAMACs presently operating in the USSR, USA, France, UK, Federal Republic of Germany, and Italy. Japan is building a TOKAMAC, also with a 3.0 metre radius, which is scheduled for completion in late 1981. A 2.5 metre TOKAMAC is under construction in the US, and should begin operating in late 1982. (photo courtesy of JET Joint Undertaking).



obtained in larger devices. Many now believe that the TOKAMAC will be the first fusion device to achieve net energy production.

In order to achieve fusion temperatures, the plasma must be heated faster than the very rapid heat loss by radiation. Until recently, the only method of heating used in TOKAMACs was by passing an electric current through the plasma. This becomes less and less effective as higher plasma temperatures are attained. Several new, and more efficient, means of plasma heating are now being applied. One of the most promising uses a beam of high-energy neutral atoms to heat the plasma. The injector, located outside the main TOKAMAC chamber, initially ionizes hydrogen or deuterium, and accelerates the ions with 80-160,000 volts. The ion beam is neutralized before entering the magnetic field of the TOKAMAC, where it transfers energy to plasma nuclei through collisions.

During the fusion reaction, some plasma inevitably escapes the magnetic field and contacts the wall of the reaction chamber. This constitutes an obvious loss of heat energy from the reaction zone, but even more serious is the effect of introducing impurity atoms from the reactor wall. Upon entering the plasma, these atoms are stripped of many — but not all — electrons. These incompletely-ionized atoms emit ultraviolet and x-ray radiation. The result is a major heat loss from the reaction zone.

Radiative heat loss from plasma impurities is reduced by using low atomic weight materials for wall linings and other reactor components in contact with the plasma. Much recent research centers upon carbon and carbides, because of the low radiative power loss accompanying their appearance as impurities in a plasma. But even with these materials, it will be important to eliminate plasma contamination from the reactor wall.

The interactions of high-energy plasma particles with reactor walls is one area of research at Culham Research Laboratories near Abingdon UK, site of the largest TOKAMAC to be built, the Joint European Torus (JET). Operation of the device, when it is completed, will involve participation of scientists from the Netherlands, Belgium, France, Denmark, Federal Republic of Germany, Italy and the UK.

Surprising results have been obtained by Culham research workers simulating contact of high-temperature plasmas with carbon-lined reactor walls. They accelerate deuterium nuclei to very high energies that would be encountered in a fusing plasma, and slam them into the surface of carbon. The researchers have found that the impact is not simply a physical collision process. Once deuterium ions penetrate the surface and are slowed to normal thermal energies, they react chemically. Deuterium ions or atoms diffuse through the carbon and produce deuterated methane. Escape of methane from the surface can be an order of magnitude greater than the amount ejected by sputtering, the

physical process of momentum transfer from impacting ions to atoms in the material surface. Methane formation can, under some conditions, be the primary cause of carbon entering the reaction zone and for the deterioration of reactor surfaces. It is not surprising that the main interest of investigators at Culham is to avoid methane formation.

Formation of deuterated methane by impact of deuterium ions on a carbon surface depends strongly upon the surface temperature. The methane yield reaches a distinct maximum when the carbon surface is about 500°C. The yield (about 0.03 CD<sub>4</sub> molecules/incident ion) drops more than ten-fold with a 200°C rise or fall in surface temperature. This behavior remains essentially unchanged as the incident ion beam energy or flux is varied.

The initial conclusion reached by Culham researchers C. M. Braganza, S. K. Erents and G. M. McCracken, is simple: don't operate a carbon component of a fusion reactor at 500°C. The material should be cooled to about room temperature, or heated above 700°C. Below 500°C, it seems that the reaction occurs more slowly than the impacting deuterium ions can diffuse to the surface and escape. At surface temperatures above 500°C, formation of methane becomes more rapid, but deuterium atoms diffuse to the surface at an even faster rate.

A different type of damage results from neutron impact on reactor walls. Neutrons are produced by the deuterium-tritium fusion reaction with a characteristic energy of 14.1 MeV. This neutron energy is much higher than is encountered in fission reactors. The nature of damage done by such energetic neutrons is still a major unknown in engineering studies of fusion reactor design.

It is known that impacting neutrons damage materials in several ways. Collisions cause atoms to recoil from their sites in the crystal structure, leaving vacancies. Alternately, atomic nuclei can absorb neutrons, leading to the release of a proton or helium nucleus. When neutralized, these form gas bubbles of hydrogen and helium. Blistering of the surface could cause particles of wall material to be carried into the reaction zone.

The effect of 14.1 MeV neutrons on material surfaces has been difficult to simulate in experiments. Until very recently, studies with 14 MeV neutron sources have been limited to a neutron flux of less than  $2 \times 10^{12}$  neutrons/cm<sup>2</sup>-second. With this low source intensity, more than 50 years would be required to simulate the damage suffered by wall material in a fusion reactor during one year of operation. But the ability of researchers to study neutron damage has been enhanced by the opening of a new facility in January at Lawrence Livermore Laboratory in the USA. The new device provides two independent 14 MeV neutron sources, both six times more intense than available previously.



# A new idea, but catching up fast:

## Laser Fusion

Very different criteria apply to the selection of materials for fusion reactors utilizing inertial confinement. Research in this area is presently farthest ahead in the USA with its advanced laser technology, an important ingredient for successful attainment of break-even energy production. This method relies upon an extremely powerful burst of laser light less than one-billionth of a second in duration. The beam is focussed from several directions onto a small (1 mm diameter) pellet containing compounds of tritium and deuterium. The outside of the pellet vaporizes nearly instantaneously. The vaporized (and ionized) material cannot escape during the duration of the laser pulse, and is transformed into a layer of hot plasma with nearly the same density as the original solid material. Enormous pressure is exerted on the remaining pellet material, causing it to be compressed. Outer layers of the compressed pellet continue to vaporize, compressing even more the pellet interior. The result is an implosion of the pellet. Fusion begins at the center of the resulting plasma, where deuterium and tritium ions have about 1000 times the density of the original pellet material. The fusion reaction then heats the surrounding plasma and radiates outward.

Continued development of the inertial confinement method will require lasers and laser amplifiers more powerful than any yet built. The largest laser fusion experiment is presently the Shiva installation at the Lawrence Livermore Laboratories in the USA. Their system of 20 laser amplifier chains can deliver laser pulses of 30 trillion watts power. An addition to the Shiva experiment will increase the scale of the project nearly ten-fold, and could allow break-even to be attained in the mid-1980's.

The extremely short duration of the laser fusion reaction subjects the walls of the surrounding chamber to an very intense burst of reflected laser light, x-rays, neutrons and high-velocity ions and electrons. Cumulative exposure, averaged over the time between fusion burst, will be about the same as in conventional nuclear reactors — but the *instantaneous* level of radiation during each burst will be up to 100 million times greater. Preliminary evidence suggests that radiation damage processes are quite different for such intense exposure. In the short duration of the radiation burst, there will not be time for heat to dissipate, or for chemical rearrangement following injection of gas atoms. Most of the radiation will be absorbed within one micron of the wall surface. This superficial layer of the wall material will bear most of the heat load of the radiation blast. A fundamental problem which remains to be overcome in laser fusion reactors is

preventing the surface of the reactor wall from melting or vaporizing.

Radiation encountered in laser fusion devices will have entirely different characteristics than that found in magnetic fusion devices or conventional fission reactors. One specialist in nuclear engineering materials, Prof. G. L. Kulcinski at the University of Wisconsin (USA), points out that "the unique spectrum of high energy neutrons, and the addition of high fluxes of charged particles and x-rays, combine to produce an environment never faced by materials scientists". In his recent paper *The Newest Frontier in Radiation Damage Research — Laser Fusion Reactors*, Prof. Kulcinski concludes that "we are on the threshold of a completely different type of radiation damage environment, and if plasma physicists and laser experts are successful . . . the material scientist will face a great challenge in handling the emitted radiation".

In contrast to fusion in magnetically-confined plasmas, in which nearly all neutrons leave the reaction with 14.1 MeV energy, neutrons generated during laser fusion are scattered by tritium and deuterium atoms. Most arrive at the reactor wall with energies considerably less than 14 MeV. The wide spread in neutron energy has a pronounced effect on the time required for neutrons to travel the 5-10 metre distance to the reactor wall. This is very important because neutrons carry much of the energy produced by the fusion reaction. Their delay in reaching the reactor wall allows some heat to dissipate from the surface of the wall material. In fact, initial heating by x-rays and reflected laser light has been largely dissipated by the time the first high-energy neutrons arrive at the reactor wall about 100 nanoseconds later.

Nonetheless, analysis of radiation emitted during laser fusion experiments indicates that carbon, copper and molybdenum surfaces would become too hot if the walls endured the brunt of the radiation. Material within 5 microns of the surface would undergo a temperature rise of 400-600°C. Various approaches have been proposed to reduce the heat load on the wall: covering with a film of liquid lithium, magnetic fields to divert the charged particles, and filling the chamber with low pressure gas. The presence of gas inside the reaction chamber, for example, could absorb helium atoms and significantly modify the energy distribution of plasma particles and x-rays such that the maximum temperature rise of the wall surface is reduced by half. These results are encouraging, but not the final answer. Much more needs to be done before the materials science aspects of fusion are considered solved.



# A global approach to energy supplies

Many people living in oil-importing nations resent the rapid oil prices rises and supply disruptions following recent policy decisions made by Oil Producing and Exporting Countries (OPEC). The average person has had little opportunity to hear these actions explained or justified. Perhaps if they did, there could be better understanding of the problems ahead, constructive ideas presented, and more cooperation between OPEC and oil-consuming nations.

Presented here are main points condensed from a seven-page article "Stability of Oil Supplies: A Producer's Viewpoint", which appeared in the March issue of *OPEC Review: An Energy and Economic Forum*. Views expressed by the author are not necessarily those of OPEC, but are published here with permission of OPEC.

by Mr. Nordine Ait-Laoussine  
Executive Vice-President  
SONATRACH of Algeria\*

If we look at the stability of oil supplies from the viewpoint of the Member Countries of OPEC, the questions may be posed as to whether OPEC should — and whether it could — continue to play its traditional role as the balancing element in world oil supply. After all, demand in OPEC countries is currently in a phase of very rapid growth, typically at a rate of 15-20% per year. It has been forecast that internal demand in OPEC countries could possibly reach 20 million barrels/day by the year 2000 — roughly equal to the present consumption of the US. OPEC countries naturally want oil to play the same role in their own economy that it does in the industrialized world. It would be a very selfless government which did not give such demands priority over meeting export requirements. In some countries, Algeria and Venezuela for example, there is a real possibility of moving from export to import of oil by the turn of the century.

Many OPEC member countries therefore face a painful dilemma: the industrialized world is expecting them to significantly increase their level of exports precisely at the time when their ability to do so is being more dramatically reduced by rapidly rising internal demand.

Since 1975, the world reserve/production ratio of petroleum has decreased from 32.7 to 29.0 years. To maintain the reserve/production ratio at the present level requires finding, each year, two fields the size of Prudhoe Bay in Alaska, or three the size of Hassi Messaoud in Algeria or almost four the size of Berri

in Saudi Arabia. Unless such spectacular discoveries become almost a daily event, the world's known reserves of oil will be exhausted by the year 2000, even if demand grows at only half its historic rate.

As a matter of practical politics, it is clear that if a world crisis of unprecedented magnitude is to be averted, the OPEC producers must continue to meet their responsibility for producing the consuming world's net oil requirements, at least until the consumers have made significant progress in developing alternative energy sources. But if OPEC is to make this sort of commitment, with all its implications on the rate at which members countries deplete their natural resources, it is clear that the consumers must accept a new set of responsibilities vis-a-vis the oil producers.

Clearly, the first of these is the question of price. Consumers must accept the need for progressive increases in the price of oil in real terms, so that the price of oil reaches its real displacement cost (the cost of alternative energy supplies that producers will have to bear when their resources are exhausted) well before impending scarcity removes the possibility of an orderly transition. Let me make it plain that I have no doubt that oil prices will rise to the level of replacement costs; my point here is that consumers must accept the desirability — as well as the inevitability — of this process and must actively participate in a smooth and orderly transition from one level to the next.

The second issue concerns the transfer of technology. This is a real and burning issue for each and every oil producing country which is determined to move away from the status of being an exporter of a single commodity, and wishes to give its people a modern, independent and self-sufficient economy. It



is particularly relevant in the field of hydrocarbons, where the OPEC National Oil Companies have much to learn in the field of secondary recovery, exploration techniques, petrochemicals, and so forth.

Thirdly is the need to abolish discriminatory barriers to industrial development which are used to discourage, or even prevent, the OPEC countries from upgrading their hydrocarbon resources. Room must be found in the markets of the industrialized world for the output from OPEC refineries, petrochemical plants and industrial capacity.

In my view, real stability of oil supply will only come from a genuine mutuality of interest between producers and consumers. At the present moment, this mutuality of interest simply does not exist; the industrialized world continues to regard any attempt by OPEC member countries, either to industrialize or to preserve the real value of their oil revenues, as a threat to the consumer's economic self-interest. They put pressure on producers to minimize industrialization plans and maintain oil prices at unrealistically low levels. Is it any wonder if producers seize oppor-

tunities to redress this balance to the maximum extent possible? But this cannot be the best method of tackling a problem whose dimensions extend beyond any one country or group of countries. A painless transition towards the energy economy of the 21st century requires international cooperation, not confrontation. I believe that it is time to re-establish a dialogue between producers and consumers which would set the problem of future energy prices within the broader context — not only of fundamental issues of international cooperation on industrial development, but also of the creation of a new economic order based on justice and fraternity. Without such a global approach, I believe that it is impossible to talk of stability of oil supplies in any meaningful sense.

*\*SONATRACH is the Societe National pour la Recherche, la production, le transport, la transformation et la commercialisation de Hydrocarbures.*

## CONFERENCES

IUPAC meetings are indicated in bold type  
Additional information from address in parenthesis

### 1980

#### CRYSTALLOGRAPHIC COMPUTING

|                 |                                                                                                                                                                                                                                                         |                      |
|-----------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------|
| January<br>4-14 | Course on Crystallographic Computing, organised by the Int'l. Union of Crystallography in association with the Indian Institute of Science (Prof. K. Venkatesan, Department of Organic Chemistry, Indian Institute of Science, Bangalore 560012, India) | Bangalore<br>(India) |
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#### RADIO-ISOTOPES IN CLINICAL MEDICINE

|                 |                                                                                                                                                                                                     |                          |
|-----------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------|
| January<br>7-10 | 14th Int'l. Symposium of Radioactive Isotopes in Clinical Medicine and Research (Prof. Dr. R. Hoefer, Head, Nuc. Med Dept., Medical University Clinic II, Garnisongasse 13, A-1090 Vienna, Austria) | Bad Gastein<br>(Austria) |
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#### SPECTROCHEMICAL ANALYSIS OF PLASMAS

|                 |                                                                                                                                                                                                                                                                          |                                |
|-----------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------|
| January<br>7-11 | Int'l. Conference on Developments in Atomic Plasma Spectrochemical Analyses: Inductively Coupled, Microwave and D. C. Plasma Discharges (Winter Conference 1980, ICP Information Newsletter, Chemistry GRC Tower I, University of Massachusetts, Amherst, MA 01003, USA) | San Juan,<br>Puerto Rico (USA) |
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#### NEW POLYMER CHEMISTRY APPLICATIONS

|                 |                                                                                                                                                                     |                   |
|-----------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|
| January<br>7-11 | Int'l. Symposium on New Frontiers in Polymer Chemistry and Polymer Applications (Dr. N. Ramathan, Central Leather Research Institute, Adyar, Madras-600 020, India) | Madras<br>(India) |
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#### METALLIC CLUSTERS

|                |                                                                                                                                                       |                    |
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| January<br>8-9 | Diatomic Metals and Metallic Clusters, Symposium No. 14 (Dr. H. A. Skinner, Dept. of Chemistry, The University of Manchester, Manchester M13 9PL, UK) | Manchester<br>(UK) |
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#### INDUSTRIAL WASTE

|                 |                                                                                                                                                                                           |                       |
|-----------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|
| February<br>6-8 | 3rd International Congress on Industrial Waste Water and Wastes (Mr. B. Goransson, Institutet for Vatten-och Luftvardsforskning, POB 21060, Halsingegatan 43, S-100 31 Stockholm, Sweden) | Stockholm<br>(Sweden) |
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#### DEGRADATION OF ORGANIC COATINGS

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| March<br>3-7 | Symposium on Photodegradation, Photo-oxidation and Photostabilization of Organic Coatings 179th ACS National Meeting (F. H. Winslow, Bell Laboratories, Murray Hill, NJ 07974, USA) | Houston<br>(USA) |
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## CONFERENCES 1980

### ANALYTICAL SPECTROSCOPY

|              |                                                                                                                                                           |                         |
|--------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------|
| March<br>3-7 | 31st Pittsburgh Conference on Analytical Spectroscopy (Analytical Chemistry Group. Amer. Chem. Soc., 1155 16th Street N.W., Washington, DC 20036, U.S.A.) | Cleveland<br>Ohio (USA) |
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### RADIATION PROTECTION

|               |                                                                                                                                             |                       |
|---------------|---------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|
| March<br>9-14 | 5th Int'l. Congress of Radiation Protection (Dr. T. Schlesinger, Israel Health Physics Society, Soreq Nuclear Research Ctr. Yavneh, Israel) | Jerusalem<br>(Israel) |
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### METAL HYDRIDES

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| March<br>16-21 | International Symposium on the Properties and Applications of Metal Hydrides (Dr. G. D. Sandrock, Inco R&D Ctr., Int. Nickel Co., Sterling Forest, Suffern, NY 10901, USA) | Colorado Springs<br>Colorado (USA) |
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### AMERICAN CHEMICAL SOCIETY

|                |                                                                                              |                  |
|----------------|----------------------------------------------------------------------------------------------|------------------|
| March<br>23-28 | ACS Spring Meeting (American Chemical Society, 1155 16 Street NW, Washington, DC 20036, USA) | Houston<br>(USA) |
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### CHEMICAL REACTION ENGINEERING

|                |                                                                                                                                                                                        |                  |
|----------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------|
| March<br>25-27 | 6th International Symposium on Chemical Reaction Engineering (Prof. Jacques Villermaux, Laboratoire des Sciences du Genie Chimique, CNRS-ENSIC, 1 rue Grandville, 54042-Nancy, France) | Nice<br>(France) |
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### POLYMER FLOW PROPERTIES

|                |                                                                                                                                                                                 |                      |
|----------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------|
| March<br>26-28 | Int'l. Conference on Practical Rheology in Polymer Processing (Dr. D. E. Marshall, Institute of Polymer Technology, University of Technology, Loughborough, Leics LE11 3TU, UK) | Loughborough<br>(UK) |
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### HYDRODYNAMICS

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|-------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------|
| March or<br>April | 1979 Int'l. Physicochemical Hydrodynamics Conference (Ms C. I. King, Physicochemical Hydrodynamics conference Committee (PCH), c/o PCH Conf. Off., 3400 Blue Spring Rd., Suite A7, Huntsville, AL 35810, USA) | (Spain) |
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### LIQUEFIED NATURAL GAS

|               |                                                                                                                              |                  |
|---------------|------------------------------------------------------------------------------------------------------------------------------|------------------|
| April<br>6-11 | Int'l. Conference on Liquefied Natural Gas (Dr. David Roe, British Gas Corporation, 59 Bryanston Street, London W1A 2AZ, UK) | Kyoto<br>(Japan) |
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### PLASMA PHYSICS

|               |                                                                                                                                |                            |
|---------------|--------------------------------------------------------------------------------------------------------------------------------|----------------------------|
| April<br>7-11 | International Conference of Plasma Physics (K. Nishikawa, Institute for Fusion Theory, Hiroshima University, Hiroshima, Japan) | Tokyo or Nagoya<br>(Japan) |
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### BIOMATERIALS

|               |                                                                                                                                                     |                     |
|---------------|-----------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|
| April<br>8-12 | 2nd World Congress on Biomaterials (Dr. J. L. Leray, Pavillon Ollier Hopital Cochin, 27 rue du Faubourg St-Jacques, F-75674 Paris Cedex 14, France) | Vienna<br>(Austria) |
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### UK CHEMICAL SOCIETY CONGRESS

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|---------------|---------------------------------------------------------------------------------------|----------------|
| April<br>9-11 | Annual Chemical Congress (The Chemical Society, Burlington House, London W1V 0BN, UK) | Durham<br>(UK) |
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### SPECTROSCOPY

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| April<br>10-11 | 2nd International Conference on Spectroscopy (Alena Enterprises of Canada (ALENCA), Box 1779, Cornwall, Ontario, Canada K6H 5V7) | Anaheim,<br>California (USA) |
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### CHEM. ENGINEERING/SCANDINAVIA

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|----------------|-------------------------------------------------------------------------------------------------------------------------------|-------------------------|
| April<br>14-16 | 5th Int'l. Scandinavian Congress of Chemical Engineering (Bella-Centret A/S, Center Boulevard, DK-2300 Copenhagen S, Denmark) | Copenhagen<br>(Denmark) |
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### SOLIDS SEPARATION

|                |                                                                                                                                                                                         |                     |
|----------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|
| April<br>16-18 | Int'l. Conference on Solids Separation Processes (Int'l. Conference on Solids Processing, The Institution of Chemical Engineers, BeMRA, Tramway House, Dartry Road, Ireland — Dublin 6) | Dublin<br>(Ireland) |
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## CONFERENCES 1980

### BIO-ENERGY

|                |                                                                                                                                                                                  |                           |
|----------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------|
| April<br>21-25 | Bio-Energy World Congress and Exposition (Bio-Energy 1980) (P. Schauffler, Development Dir., Bio-Energy Council (BEC), 1625 Eye St. NW, Suite 825-A, Washington, DC, 20006, USA) | Atlanta,<br>Georgia (USA) |
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### PHOSPHORUS COMPOUNDS

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|----------------|-----------------------------------------------------------------------------------------------------------|-----------------|
| April<br>21-25 | Second International Congress on Phosphorus Compounds (IMPHOS-8, rue de Pentièvre, F-75008 Paris, France) | Boston<br>(USA) |
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### ENVIRONMENTAL MONITORING

|       |                                                                                                                                                                                                             |                          |
|-------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------|
| April | 14th Int'l. Symposium on Remote Sensing of the Environment (J. J. Cook, Environmental Research Institute of Michigan (ERIM), Ctr. for Remote Sensing Infor. & Analysis, Box 8618, Ann Arbor, MI 48107, USA) | San Jose<br>(Costa Rica) |
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### POLLUTED ATMOSPHERES

|            |                                                                                                                                                          |                   |
|------------|----------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|
| May<br>5-7 | 14th Int'l. Colloquium on Polluted Atmospheres (M. Benarie, National Institute for Applied Chemical Research (IRChA), BP 1, 91710 Vert-le-Petit, France) | Paris<br>(France) |
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### CEREAL CHEMISTRY

|            |                                                                                                                                             |                     |
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| May<br>7-9 | 10th Congress of the Int'l. Assoc. of Cereal Chemistry (Int'l. Assoc. for Cereal Chemistry, Schmidgasse No. 3-7, A-2320 Schwechat, Austria) | Vienna<br>(Austria) |
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### ENVIRONMENTAL POLLUTION

|            |                                                                                                                                      |                     |
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| May<br>8-9 | International Environmental Pollution Conference (Alena Enterprises of Canada (ALENCA), Box 1779, Cornwall, Ontario, Canada K6H 5V7) | Toronto<br>(Canada) |
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### NON-METALS IN METALS

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|--------------|--------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|
| May<br>10-13 | Non-Metals in Metals (Gesellschaft Deutscher Chemiker, Abt. Fachgruppen, Postfach 900440 D-6000 Frankfurt(Main) 90, Federal Republic of Germany) | Berlin<br>(FRG) |
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### GENERAL MEETING ANZAAS

|              |                                                                                                                                                        |                         |
|--------------|--------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------|
| May<br>12-16 | 50th Congress of the Australian and New Zealand Association for Advancement of Science (Dr. J. R. Best, 141 Rundle Mall, Adelaide, SA 5000, Australia) | Adelaide<br>(Australia) |
|--------------|--------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------|

### ION EXCHANGE

|              |                                                                                                                                            |                           |
|--------------|--------------------------------------------------------------------------------------------------------------------------------------------|---------------------------|
| May<br>27-30 | 4th Symposium on Ion Exchange (Prof. J. Inczedy, Organizing Committee, 4th Symposium on Ion Exchange, P.O.B. 28, Veszprem, Hungary H-8201) | Balaton Lake<br>(Hungary) |
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### POLLUTANT ANALYSIS

|              |                                                                                                                                                                                                   |                   |
|--------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|
| May<br>28-30 | 10th Annual Symposium on the Analytical Chemistry of Pollutants (Dr. J. Wendenburg, Gesellschaft Deutscher Chemiker, P.O. Box 90 04 40, D-6000 Frankfurt am Main 90, Federal Republic of Germany) | Dortmund<br>(FRG) |
|--------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|

### ZEOLITES

|             |                                                                                                                                                           |                   |
|-------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|
| June<br>2-6 | 5th International Conference on Zeolites (Prof. R. Sersale, Istituto di Chimica Applicata, Università di Napoli, Piazzale Tecchio, I-80125 Napoli, Italy) | Naples<br>(Italy) |
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### SOLUTE-SOLVENT INTERACTIONS

|             |                                                                                                                                                                                                                                     |                     |
|-------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|
| June<br>2-6 | 5th International Symposium on Solute-Solute-Solvent Interactions (Prof. I. Bertini, Facoltà di Farmacia, Istituto di Chimica Generale e Inorganica, Università degli Studi di Firenze, Via Gino Capponi 7, I-50121 Firenze, Italy) | Florence<br>(Italy) |
|-------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|

## CONFERENCES 1980

### PARTICLE TECHNOLOGY IN CHEMICAL ENGINEERING

- June 3-5      Symposium on Particle-Technology — European Federation of Chemical Engineering (Ir. M.A.G. Vorstam, TH Eindhoven, afd. BAK Gr. Fys. Technologie, Postbus 513, Eindhoven, Netherlands)      Amsterdam (Netherlands)

### CHROMATOGRAPHY

- June 5-6      3rd World Chromatography Conference (Alena Enterprises of Canada (ALENCA), Box 1779, Cornwall, Ontario, Canada K6H 5V7)      Zurich (Switzerland)

### XENOBIOCHEMISTRY

- June 9-13      International Conference on Xenobiochemistry (Secretariat: Biochemical Institute, Comenius University, Kolinciakova 8, 880 34 Bratislava, Czechoslovakia)      Bratislava (Czechoslovakia)

### URETHANE CHEMISTRY

- June 9-13      International Urethane Conference (Dr. Franzkarl Brochhagen, Bayer AG, PU-A, 5090 Leverkusen, F.R. Germany)      Strasbourg (France)

### MASS SPECTROMETRY IN BIOLOGY

- June 9-14      3rd Int'l. Symposium on Quantitative Mass Spectrometry in the Life Sciences (Prof. Dr. A. de Leenheer, Sect., Int'l. Symposium on Quantitative Mass Spectrometry in Life Sciences (Org. Committee) (ISQMSLS)m c/o Lab v Med Biochemie en Klinische Analyse, Rijkuniv-Gent, 135 De Pintelaan, B-9000 Ghent, Belgium)      Ghent (Belgium)

### ORGANIC SYNTHESIS

- June 15-20      3rd IUPAC Symposium on Organic Synthesis (Prof. B. M. Trost, Department of Chemistry, University of Wisconsin—Madison, 1101 University Avenue, Madison, WI 53706, USA)      Madison, Wisconsin (USA)

### CHEMICAL EDUCATION

- June 22-26      6th Biennial Conference on Chemical Education (L. Fine, Dept. of Chemistry, Housatonic College, Bridgeport, Conn. 06608 USA).      Rochester, New York (USA)

### WATER POLLUTION RESEARCH

- June 23-27      10th Int'l. Conference on Water Pollution Research (Int. Assn. on Water Pollution Research (IAWPR) Chichester House, 278 High Holborn, London WC1V 7HF, UK)      Toronto (Canada)

### ORIGIN OF LIFE

- June 23-28      6th Int'l. Conference on the Origin of Life (Dr. M. Paecht-Horowitz, Polymer Dept., Weizman Institute Institute of Science, Rehovot, Israel)      Jerusalem (Israel)

### MEDICAL CHEMISTRY

- June      17th National Medical Chemistry Symposium (Division of Medical Chemistry, Amer. Chem. Soc., 1155 16th Street N.W., Washington D.C. 20036)      Rensselaer, New York (USA)

### POLYVINYL CHLORIDE

- June      3rd International Symposium on Polyvinyl Chloride (Dr. E. A. Collins, Diamond Shamrock Corporation, PO Box 348, Painesville, OH 44077, USA)      Cleveland, Ohio (USA)

### HYDROGEN ENERGY

- June 27-July 1      3rd World Hydrogen Energy Conference (Secretariat, 3rd World Hydrogen Energy Conference, Japan Convention Services Inc. Nippon Press Center Bldg, 2-2-1 Uchisaiwai-cho, Chiyoda-ku, Tokyo 100, Japan)      Tokyo (Japan)



## CONFERENCES 1980

### CHROMATOGRAPHY

- June 30 - 13th Int'l. Symposium on Chromatography Cannes  
July 4 (Prof. G. Guiochon, Ecole Polytechnique, Laboratoire de (France)  
Chimie, Analytique Physique, Rte, de Saclay,  
F-91128 Palaiseau Cedex, France)

### CATALYSIS

- June 30 - 7th International Congress on Catalysis (Prof. I. Yasumori, Tokyo  
July 4 Department of Chemistry, Tokyo Institute of Technology, (Japan)  
2-12-1 Ookayama, Meguro-ku, Tokyo 152, Japan)

### MACROCYCLIC LIGANDS

- July Symposium on Macrocyclic Ligands (Prof. T. A. Kaden, Basle  
3-5 Institut für Anorganische Chemie der Universität Basle, (Switzerland)  
Spitalstrasse 51, CH-4056 Basle, Switzerland)

### DRYING

- July 2nd Int'l. Symposium on Drying (Dr. A.S. Mujumadar, Montreal  
6-9 Program Chairman, Dept. of Chemical Engineering, (Canada)  
McGill University, 3480 University Street, Montreal,  
Quebec Canada)

### THERMAL ANALYSIS

- July 6th Int'l. Conference on Thermal Analysis (ICTA '80) Bayreuth  
6-12 (6th ICTA '80, Postfach 1120, D-8672 Selb, (FRG)  
Federal Republic of Germany)

### CARBOHYDRATE CHEMISTRY

- July 10th International Symposium on Carbohydrate Chemistry Sydney  
7-11 (Prof. S. J. Angyal, School of Chemistry, University of (Australia)  
New South Wales, P. O. Box 1, Kensington, New South  
Wales 2033, Australia)

### TOXICOLOGY

- July 2nd Int'l. Congress on Toxicology (Prof. M. Mercier, Brussels  
7-11 Univ Catholique de Louvain, Lab. de Chimie Med (Belgium)  
Toxicologie et Bromatologie, Tour Van Helmont, UCL  
7369, Ave Emm Mounier 73, 1200 Brussels, Belgium)

### COORDINATION CHEMISTRY

- July Int'l. Conference on Coordination Chemistry (Prof. F. Gallais, Toulouse  
7-11 1980 ICCS, Laboratoire de Chimie de Coordination du (France)  
CNRS, B. P. 4142, 31030 Toulouse Cedex, France)

### MINERAL AND ENERGY RESOURCES

- July 26th International Geological Congress: Mineral resources; Paris  
7-17 Energy resources; Geology of the oceans, of continental (France)  
margins, of alpine chains, of Europe, of France (Dr.  
W. W. Hutchinson, IUGS Sec. Gen., Geological Survey of  
Canada K1A 0E8)

### PHOTOCHEMISTRY

- July 8th Symposium on Photochemistry (Prof. J. Scharl, Seefeld  
13-19 Institut für Organische und Pharmazeutische Chemie, (Austria)  
Universität Innsbruck, Innrain 52a, A-6020 Innsbruck, Austria)

### FERMENTATION

- July 6th International Fermentation Symposium (Prof. J. E. London,  
20-25 Zajic, Faculty of Engineering Science, University of Western Ontario, (Canada)  
Ontario, London, Ontario, Canada N6A 5B9)

### PHOTOBIOLOGY

- July 8th International Congress on Photobiology (M. Charlier, Strasbourg  
20-25 Congres International de Photobiologie, Centre de Biophysique (France)  
Centre de Biophysiques Moleculaire, 1A avenue de la  
Recherche Scientifique, 45045 Orleans Cedex, France)

### ANALYTICAL CHEMISTRY

- July SAC 80: International Conference on Analytical Chemistry Lancaster  
20-26 (Dr. J. D. R. Thomas, Department of Chemistry, (UK)  
UWIST, King Edward VII Avenue, Cardiff CF1 3NU, UK)

## CONFERENCES 1980

### GERMANIUM, TIN AND LEAD

|               |                                                                                                                                                                                                      |                            |
|---------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------|
| July<br>21-25 | 3rd International Conference on the Organometallic and Coordination Chemistry of Germanium, Tin and Lead (Dr. W. Fritsche, Gesellschaft Deutscher Chemiker, POB 900 9 440, D-6000 Frankfurt, F.R.G.) | Dortmund<br>(F.R. Germany) |
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### IMMUNOLOGY

|               |                                                                                                                                        |                   |
|---------------|----------------------------------------------------------------------------------------------------------------------------------------|-------------------|
| July<br>21-26 | 4th International Congress of Immunology (Dr. A. L. de Weck, Institut für Klinische Immunologie, Inselspital, 3010 Berne, Switzerland) | Paris<br>(France) |
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### PHOTOBIOLOGY

|               |                                                                                                                                                                |                        |
|---------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------|
| July<br>21-26 | 8th Int'l. Congress of Photobiology (Dr. M. Charlier, Centre de Biophysique Moleculaire, 1 avenue de la Recherche Scientifique, F-45045 Orléans Cedex, France) | Strasbourg<br>(France) |
|---------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------|

### CHEMISTRY IN AFRICAN DEVELOPMENT

|                    |                                                                                                                                                                                                                            |                    |
|--------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------|
| July 28-<br>Aug. 1 | The first International Chemistry Conference in Africa, entitled "Chemistry in the Development and Environment of Africa" (Dr. S. Wandiga, chairman Dept. of Chemistry, Univ. of Nairobi, P.O. Box 30197, Nairobi, Kenya). | Nairobi<br>(Kenya) |
|--------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------|

### PHOTOCHEMICAL ENERGY STORAGE

|                   |                                                                                                                                                                             |                   |
|-------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|
| July or<br>August | 3rd Int'l. Conference on Photochemical Conversion and Storage of Solar Energy (Dr. J. S. Connolly, Solar Energy Research Institute, 1536 Cole Boul., Golden, CO 80401 USA). | Colorado<br>(USA) |
|-------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|

### PHOTOSYNTHESIS

|                   |                                                                                                                                                          |                   |
|-------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|
| July or<br>August | 5th Int'l. Congress on Photosynthesis (Dr. G. Akoyunoglou, IPC, Dept. of Biology, Nuclear Research Centre, Demokritos, Aghia Parascheri, Athens, Greece) | Corfu<br>(Greece) |
|-------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|

### CONVERSION OF SOLAR ENERGY

|                   |                                                                                                                                                                                   |                   |
|-------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|
| July or<br>August | Third Int'l. Conference on Photochemical Conversion and Storage of Solar Energy (Dr. J. S. Connolly, Solar Energy Research Institute, 1536 Cole Boulevard, Golden, CO 80401, USA) | Colorado<br>(USA) |
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### PHARMACOLOGY

|               |                                                                                                                                                                                     |                |
|---------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------|
| August<br>3-8 | World Conference on Clinical Pharmacology and Therapeutics (Prof. C. T. Dollery, Dept. of Clinical Pharmacology, Royal Postgraduate Medical School, Ducane Rd., London W12 0HS, UK) | London<br>(UK) |
|---------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------|

### RAMAN SPECTROSCOPY

|               |                                                                                                                                                                                                               |                    |
|---------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------|
| August<br>4-9 | 7th International Conference on Raman Spectroscopy (Mr. K. Charbonneau, Exec. Sec., 7th International Conference on Raman Spectroscopy, National Research Council of Canada, Ottawa, Ontario, Canada K1A 0R6) | Ottawa<br>(Canada) |
|---------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------|

### ATMOSPHERIC RADIATION

|                 |                                                                                                                                                  |                                |
|-----------------|--------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------|
| August<br>11-15 | Symposium on Radiation in the Atmosphere (Prof. T. H. Vonder Haar, Colorado State Univ., Dept. of Atmospheric Sci., Fort Collins, CO 80521, USA) | Fort Collins<br>Colorado (USA) |
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### COMBUSTION

|                 |                                                                                                                                                                 |                      |
|-----------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------|
| August<br>17-22 | 18th International Symposium on Combustion (Mrs. M. C. Salamony, Exec. Sec., Combustion Institute, The (TCI), 986 Union Trust Bldg., Pittsburgh, PA 15219, USA) | Waterloo<br>(Canada) |
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## CONFERENCES 1980

### PHYSICAL ORGANIC CHEMISTRY

|                 |                                                                                                                                                                        |                                    |
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| August<br>17-22 | 5th IUPAC Conference on Physical Organic Chemistry<br>(Prof. J. F. Bunnett, Division of Natural Sciences - II,<br>University of California, Santa Cruz, CA 95064, USA) | Santa Cruz,<br>California<br>(USA) |
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### ENERGY CONVERSION

|                 |                                                                                                                                 |                              |
|-----------------|---------------------------------------------------------------------------------------------------------------------------------|------------------------------|
| August<br>18-22 | 15th Intersociety Energy Conversion Engineering Conference<br>(S. Silverman, 19630 Marine View Drive S.W.,<br>Seattle, WA, USA) | Seattle,<br>Washington (USA) |
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### TRANSITION METALS

|                 |                                                                                                                                               |               |
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| August<br>18-22 | Int'l. Conference on the Physics of Transition Metals<br>(Meetings Officer, The Institute of Physics, 47 Belgrave Square,<br>London SW1X 8WX) | Leeds<br>(UK) |
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### BIOCHEMISTRY

|                 |                                                                                                                                        |                       |
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| August<br>24-29 | 13th Meeting of the Federation of European Biochemical<br>Societies (Prof. N. Sharon, Weizman Institut of Science,<br>Rehovot, Israel) | Jerusalem<br>(Israel) |
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### NORTH AMERICAN CHEMICAL CONGRESS

|                 |                                                                                                                                                                                              |                                    |
|-----------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------|
| August<br>24-29 | 2nd Chemical Congress of the North American Continent<br>(A.T. Winstead, Head, Meetings & Div. Activities, American<br>Chemical Society (ACS), 1155 16 St. NW, Washington,<br>DC 20036, USA) | San Francisco,<br>California (USA) |
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### THERMODYNAMICS

|                 |                                                                                                                                                                                                                   |                    |
|-----------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------|
| August<br>26-29 | 6th International Conference on Thermodynamics (Prof.<br>Dr. Margit T. Ratzsch, Technische Hochschule "Carl<br>Schorlemmer" Leuna-Merseburg, Geusaer Strasse,<br>DDR-42 Merseburg 6, Germany Democratic Republic) | Merseburg<br>(GDR) |
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### HYDROGEN IN METALS

|                 |                                                                                                                                                                        |                         |
|-----------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------|
| August<br>26-31 | International Conference on Hydrogen Effects in Metals<br>(Prof. I.M. Bernstein, Dept. of Metallurgy & Matls Sci.<br>Carnegie-Mellon Unvi., Pittsburgh, PA 15213, USA) | Moran,<br>Wyoming (USA) |
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### OZONE

|        |                                                                                                                                                |                            |
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| August | Ozone Symposium (Mr S. Ruttenberg, Sec. Int'l. Assoc. of<br>Meteorology & Atmospheric Physics, NCAR, P.O. Box<br>3000, boulder, CO 80307, USA) | Boulder,<br>Colorado (USA) |
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|  |                                                                                                                                                                       |                            |
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|  | Workshop on Calibration & Intercomparison of Ozone<br>Measurement Techniques (Secretariat, Committee on<br>Space Research, 51 bd de Montmorency, 75016 Paris, France) | Boulder,<br>Colorado (USA) |
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### FLOW PROPERTIES

|                      |                                                                                                                                            |                   |
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| Aug. 31 -<br>Sept. 6 | 8th Int'l. Congress of Rheology (Prof. G. Astaria, Istituto di<br>Principi di Ingegneria Chimica, Piazzale Tecchi,<br>80125 Napoli, Italy) | Naples<br>(Italy) |
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### REACTIVITY OF SOLIDS

|                  |                                                                                                                                                                                                  |                    |
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| September<br>1-6 | 9th Int'l. Symposium on the Reactivity of Solids<br>(Dr. J. Nowotny, Institute of Catalysis and Surface<br>Chemistry, Polish Academy of Sciences, ul. Niezapominajek,<br>30-239, Krakow, Poland) | Cracow<br>(Poland) |
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### COMPUTERS IN CHEMICAL ENGINEERING

|                  |                                                                                                                                                                                                                                                    |                    |
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| September<br>2-5 | Chemplant '80 — Symposium of the Working Party on<br>Routine Calculations and Use of Computers in Chemical<br>Engineering — European Federation of Chemical Engineering<br>(Hungarian Chemical Society, Anker Kőz 1, 1061 Budapest VI,<br>Hungary) | Heviz<br>(Hungary) |
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### MEDICINAL CHEMISTRY

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| September<br>2-5 | 7th Int'l. Symposium on Medicinal Chemistry (7th Int'l.<br>Symposium on Med. Chemistry, 142-144 Oxford Road,<br>Cowley, Oxford, OX4 2DZ, UK) | Madrid<br>(Spain) |
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## CONFERENCES 1980

### MICROBIAL ADHESION TO SURFACES

|                  |                                                                                                                                                                                             |                 |
|------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|
| September<br>3-5 | Microbial Adhesion to Surfaces, an interdisciplinary meeting<br>(Dr. P. R. Rutter, c/o the Conference Secretariat, Society of<br>Chemical Industry, 14 Belgrave Square, London SW1X 8PS UK) | Reading<br>(UK) |
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### SOLVENT EXTRACTION

|                   |                                                                                                                                              |                    |
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| September<br>6-12 | Int'l. Solvent Extraction Conference (Secretary ISEC '80,<br>Dept. of Chemistry, University of Liege, Sart Tilman, B-4000<br>Liege, Belgium) | Liege<br>(Belgium) |
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### COAL AS A CHEMICAL FEEDSTOCK

|                   |                                                                                                                                                                                                            |                   |
|-------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|
| September<br>7-11 | Int'l. Conference on coal as a feedstock for the Chemical<br>Industry (Dr. E. Rothwell, Dept. of Chemical Engineering<br>and Fuel Technology, University of Sheffield, Mappin Street,<br>Sheffield S1 3JD) | Sheffield<br>(UK) |
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### ANALYTICAL CHEM./SPECTROSCOPY

|                   |                                                                                                                                                                             |                           |
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| September<br>7-12 | 7th Annual Meeting of the Federation of Analytical Chemistry<br>and Spectroscopy Societies (J. A. Williamson, DuPont Co.,<br>Instrument Products Div., Wilmington, DE, USA) | Philadelphia,<br>PA (USA) |
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### MACROMOLECULES

|                   |                                                                                                                                                       |                     |
|-------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|
| September<br>7-13 | International Symposium on Macromolecules (Prof. F. Ciardelli,<br>Istituto Chimica Organica Industriale, Via Risorgimento 35,<br>I-56100 Pisa, Italy) | Florence<br>(Italy) |
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### WORLD ENERGY

|                   |                                                                                                                                                                                                                                   |                          |
|-------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------|
| September<br>8-12 | 11th World Energy Conference: Energy for our World<br>(Nationales Komitee der Weltenergiekonferenz für die<br>Bundesrepublik Deutschland, Graf-Recke-Str. 84, Postfach 1139,<br>D-4000 Düsseldorf 1, Federal Republic of Germany) | Munich<br>(F.R. Germany) |
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### INDUSTRIAL SAFETY

|                    |                                                                                                                                                                                                                                       |                        |
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| September<br>15-19 | 3rd Int'l. Symposium on Loss Prevention and Safety<br>Promotion in the Process Industries (3rd Int'l. Symposium<br>on Loss Prevention and Safety Promotion in Process Industries,<br>1980, Postfach 141, CH 4007, Basle, Switzerland) | Basle<br>(Switzerland) |
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### OXYGEN IN LIVING SYSTEMS AND INDUSTRY

|                    |                                                                                                                                                                                                                                                                 |                    |
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| September<br>15-18 | 2nd BOC Priestley Conference (Theme: production storage and<br>transport of Oxygen in living systems and by industry)<br>(Dr. John F. Gibson, Assistant Secretary (Scientific )<br>Educational), The Chemical Society, Burlington House,<br>London W1V 0BN, UK) | Birmingham<br>(UK) |
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### SAFETY IN PROCESS INDUSTRIES

|                    |                                                                                                                                                                                                                                                                                       |                        |
|--------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------|
| September<br>15-19 | 3rd International Symposium on Loss Prevention and Safety<br>Promotion in the Process Industries — European Federation<br>of Chemical Engineering (3rd Intern. Symp. on Loss Prevention<br>and Safety Promotion in the Process Industries, P.O. Box 1 41,<br>4007 Basle, Switzerland) | Basle<br>(Switzerland) |
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### FLUORINE CHEMISTRY

|                    |                                                                                                                                                            |                  |
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| September<br>15-19 | 7th European Symposium on Fluorine Chemistry<br>(Prof. G.P. Gambaretto, Istituto di Chimica Industriale della<br>Facolta di Marzola 9, 35100 Padua, Italy) | Padua<br>(Italy) |
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### CORROSION INHIBITORS

|                    |                                                                                                                                                         |                    |
|--------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------|
| September<br>15-19 | 5th European Symposium on Corrosion Inhibitors (Corrosion<br>Study Centre 'A Dacco' University of Ferrara, Via L Borsari 46,<br>I-44100 Ferrara, Italy) | Ferrara<br>(Italy) |
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### POLYMER NETWORKS

|                    |                                                                                                                                                                     |                         |
|--------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------|
| September<br>15-20 | 7th Discussion Conference on Polymer Networks (Dr. P. Cefelin,<br>PMM Secretariat, Institute of Macromolecular Chemistry,<br>1888 Petřín, Prague 6, Czechoslovakia) | Karlovy Vary<br>(Czech) |
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## CONFERENCES 1980

### MARINE NATURAL PRODUCTS

|                    |                                                                                                                                                                               |                       |
|--------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|
| September<br>16-20 | 3rd Int'l. Symposium on Marine Natural Products (Dr. J. C. Braekman, Faculte des Sciences, Avenue F.-D. Roosevelt 50, Universite Libre de Brussels, B-1050 Brussels, Belgium) | Brussels<br>(Belgium) |
|--------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|

### CRYSTAL DEFECTS

|                    |                                                                                                                                                                                           |                    |
|--------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------|
| September<br>17-21 | 3rd Europhysics topical conference on Lattice Defects in Ionic Crystals (The Secretary, Europhysics Topical Conference, Physics Laboratory, The University, Canterbury, Kent CT2 7NR UK). | Canterbury<br>(UK) |
|--------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------|

### NATURAL PRODUCTS

|                    |                                                                                                                                                                       |                     |
|--------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|
| September<br>21-27 | 12th Int'l. Symposium on Chemistry of Natural Products (Prof. A. G. González, Instituto de Productos Naturales, Carretera la Esperanza 2, La Laguna, Tenerife, Spain) | Tenerife<br>(Spain) |
|--------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|

### COSMETIC RESEARCH

|                    |                                                                                                                                      |                   |
|--------------------|--------------------------------------------------------------------------------------------------------------------------------------|-------------------|
| September<br>22-25 | 11th International Congress on Cosmetic Research and Technology (Conventions Service Italy, Piazza Mignarelli 4, 00187 Rome, Italy). | Venice<br>(Italy) |
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### SOLID SURFACES

|                    |                                                                                                                                                                 |                    |
|--------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------|
| September<br>22-26 | 8th Int'l. Vacuum Congress/4th Int'l. Conference on Solid Surfaces (1980 Steering Committee, Societe Francaise du Vide, 19 Rue de Renard, 75004, Paris, France) | Cannes<br>(France) |
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### POLYMERIZATION OF HETEROCYCLES

|                    |                                                                                                                                                                                                                                          |                          |
|--------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------|
| September<br>22-26 | 21st Prague Microsymposium on Ring-Opening Polymerization of Heterocycles (Dr. P. Cefelin, PMM Secretariat, Institute of Macromolecular Chemistry, 1888 Petriny, Prague 6, Czechoslovakia) Additional information provided in this issue | Karlovy Vary<br>(Czech.) |
|--------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------|

### MICROCHEMICAL TECHNIQUES

|                    |                                                                                                                                                                       |                   |
|--------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|
| September<br>25-30 | 8th Int'l. Symposium on Microchemical Techniques (Prof. Dr. A. Holasek, Institut fur Medizinische Biochemie, Universität Graz, Harrachgasse 21, A-8010 Graz, Austria) | Graz<br>(Austria) |
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### WATER POLLUTION CONTROL

|                      |                                                                                                                                  |                               |
|----------------------|----------------------------------------------------------------------------------------------------------------------------------|-------------------------------|
| Sept. 28 -<br>Oct. 3 | Water Pollution Control Federation International Convention (R.A. Canham, 3900 Wisconsin Avenue, NW., Washington, DC 20016, USA) | Atlantic City,<br>N.J. (USA). |
|----------------------|----------------------------------------------------------------------------------------------------------------------------------|-------------------------------|

### SCIENTIFIC DATA

|                 |                                                                                                                                                                                   |                  |
|-----------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------|
| October<br>8-11 | 7th Int'l. Conference on Data for Science and Technology (Prof. T. Shimanouchi, Electronics & Info Technology, Tsukuba Univ. Sakura-mura, Niihari-gun, Ibaraki-ken 300-31, Japan) | Kyoto<br>(Japan) |
|-----------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------|

### CATALYST DEACTIVATION

|                  |                                                                                                                                                                                                                                                                              |                      |
|------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------|
| October<br>13-15 | International Symposium on Catalyst Deactivation: Poisoning, Coke formation, Solid state chemical transformations (Prof. B. Delmon, Universite Catholique de Louvain, Group de Physico-Chemie Minerale et de Catalyse, Place Croix du Sud 1, 1348 Louvain-La-Neuve, Belgium) | Antwerp<br>(Belgium) |
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### NITROGEN FIXATION

|                 |                                                                                                                                          |                         |
|-----------------|------------------------------------------------------------------------------------------------------------------------------------------|-------------------------|
| December<br>1-5 | 4th Int'l. Symposium on Nitrogen Fixation (Dr. A. H. Gibson, CSIRO Div. of Plant Industry, Box 1600, Canberra City, ACT 2601, Australia) | Canberra<br>(Australia) |
|-----------------|------------------------------------------------------------------------------------------------------------------------------------------|-------------------------|

### BIOCHEMISTRY — ASIA AND OCEANIA

|                   |                                                                                                                                                                                                                                             |                      |
|-------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------|
| December<br>14-18 | Golden Jubilee of Society of Biological Chemists (India) and Second Congress of the Federation of Asian and Ocean Biochemists (Mr. S. Krishnamurthy, Soc. of Biol. Chemists (India), Indian Institute of Science, Bangalore 560 012, India) | Bangalore<br>(India) |
|-------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------|

The International Journal for all Chemists

# PURE AND APPLIED CHEMISTRY

**Official Journal of the International Union of  
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| R F Heck          | Y Hirata        | E C Horning    |
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| G A Somorjai      | Sukh Dev        | M Szwarc       |
| B M Trost         | M Tsutsui       | S Umezawa      |
| B C L Weedon      | K Wiesner       | G Wilke        |

\*Nobel prizewinners

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# IUPAC ACTIVITIES AT A GLANCE

The normal flow of information regarding reports, special projects, publications and new appointments on IUPAC Commissions has slowed to a trickle in anticipation of the IUPAC General Assembly to be held in September at Davos, Switzerland. At that meeting, the 1000-or-so members of IUPAC Commissions and Committees will elect new officers, get together within their own groups and meet with members of other Commissions.

A new **Commission of Food Chemistry** will hold its first meeting at the General Assembly. The Commission was formed by the merger of two previously-existing Commissions dealing with Food Properties and Food Contaminants, whose work overlapped. Also meeting for the first time is a new **Commission of Pesticide Chemistry**. It was formed from the amalgamation of two Commissions in the closely related areas, Terminal Pesticide Residues and Pesticide Residue Analysis.

The CHEMRAWN (Chemical Research Applied to World Needs) planning committee will consider its next major undertaking, following the highly successful convening of the 1st CHEMRAWN conference, concerning organic raw materials derived from sources other than petroleum. No doubt, detailed plans will be finalized at the General Assembly for the 2nd CHEMRAWN conference, tentatively entitled "World Conference on Chemistry, Agriculture and Food Supply" to be held in 1981. At the Davos meeting, the committee will probably select topics for subsequent conferences as well. Proposed topics include chemistry of the oceans, future supplies of inorganic raw materials, and chemistry relating to medicine and health.

**New Officers** will be elected or officially enter office at the General Assembly. Professor Heinrich Zollinger, who has served as IUPAC vice-president for the last two years, will replace Prof. G. Smets as president.

Prof. Zollinger has led a distinguished career in the chemical industry and in academic posts. After receiving his PhD degree at the University of Basle in 1944, he worked for 15 years at the Ciba Company of Basle, Switzerland. He became Lecturer in dyestuff chemistry at the University of Basle before becoming Professor at ETH (Eidgenössische Technische Hochschule) in Zurich. He became full professor in 1967. Since then, he has served as Dean of the School of Chemistry and Chemical Engineering, and as Academic Vice-President.

An outstanding Swiss chemist, Prof. Zollinger has travelled and worked extensively abroad. In 1968, he was Guest Professor at the School of Textile Chemistry of the University of New South Wales (Australia). Three years later, he was invited to the USA to be Guest Professor at the University of California and at North Carolina University. In 1973, he was Guest Professor at the Weizmann Institute of Science in Rehovot (Israel) and in 1977-78, at the Massachusetts Institute of Technology in the USA.

Prof. Zollinger has been a member of the IUPAC Organic Chemistry Division since 1965. He served as



**Prof. Heinrich Zollinger, being appointed IUPAC president at the General Assembly being held at Davos Switzerland in September.**

chairman of the Commission of Physical Organic Chemistry since it was formed in 1973, and organized the first IUPAC Conference on Physical Organic Chemistry, forerunner of a series of conferences sponsored by the Organic Chemistry Division. Prof. Zollinger has also been an active member of IUPAC's CHEMRAWN Committee.

A new vice-president, to fill Prof. Zollinger's former office, will be elected at the Davos meeting. The individual selected will follow in Prof. Zollinger's footsteps and become IUPAC president at the next General Assembly two years hence.

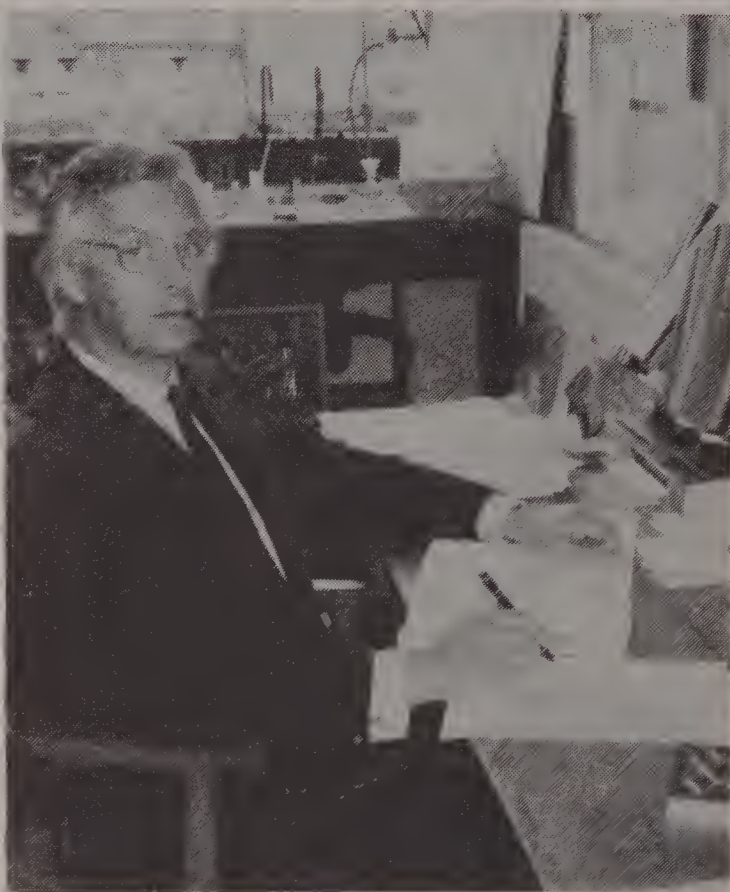
The present IUPAC secretary-general, Prof. G. Ourisson (of the Université Louis Pasteur, France) is eligible to serve another term and will continue in this post if unopposed. The man serving as IUPAC's treasurer, Prof. O. Horn (of Hoechst AG, Federal Republic of Germany) is retiring from his post, and a successor will be elected.

Those attending the Davos meeting will not be limited to present members of IUPAC's 33 Commissions, seven Divisions, and several permanent Committees. To encourage **participation of young professional chemists** who have not been formerly involved in IUPAC activities, several organizations are contributing travel and hotel expenses for selected applicants to attend the meeting. Six British applicants are being sponsored by The Royal Society of the UK; six young American chemists by the US National



Research Council's Committee for IUPAC. The Ciba Foundation (a scientific and educational charity established by Ciba Ltd, the Swiss chemical and pharmaceutical company) is sponsoring attendance of three chemists from Portugal, Ireland and Egypt. A total of 22 Swiss chemists have been nominated for sponsorship by IUPAC's Swiss Company Associates and the Swiss National Committee for IUPAC.

Not all recent IUPAC events have occurred in con-



Dr. Graham C. Barrett was appointed editor of the IUPAC journal, *Pure & Applied Chemistry*, in July. Here, he works at his desk at the Oxford Polytechnic Institute.

junction with the General Assembly, Dr. Graham C. Barrett (principal lecturer in chemistry at Oxford Polytechnic Institute) has been appointed as the new editor of the IUPAC journal *Pure & Applied Chemistry*. The journal will continue to contain papers presented at IUPAC-sponsored conferences, and technical and nomenclature reports prepared by IUPAC Commissions. Especially important is the journal's role as a medium for introducing and modifying nomenclature recommendations. These are generally published initially in provisional form, so that comments and suggestions can be made by chemists throughout the world who are knowledgeable in that subject area. Changes may be incorporated before nomenclature recommendations are approved for final publication in definitive form. Until the selection of a new editor for *Pure & Applied Chemistry*, Dr. Helmut Gr newald had served as editor for an interim period. Dr. Gr newald will also be relinquishing his chairmanship of the IUPAC Publications Committee because of his other commitments as Director of Publishing for the Chemical Society of the Federal Republic of Germany. During his tenure as chairman, Dr. Gr newald was instrumental in the creation of this magazine, *Chemistry International*.

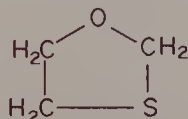
**The Commission on Medicinal Chemistry** (of the Organic Chemistry Division) has just issued their nineteenth newsletter. It reports items of general interest to medicinal chemists, as well as activities of Commission members. It lists recently-published books about pharmacology, metabolism and toxicology of drugs; reports activities of the World Health Organization and other major health groups; and provides an extensive list of conferences dealing with pharmacology, biochemistry, microbiology and related subjects. The newsletter is compiled by Dr. A. I. Rachlin, a former member of the Commission on Medicinal Chemistry. It is the only newsletter published regularly by an IUPAC Commission, although another worthwhile publication, the *International Newsletter on Chemical Education* is published (twice a year) by the IUPAC Committee on Chemical Education.

## Answers to quiz on monocyclic nomenclature

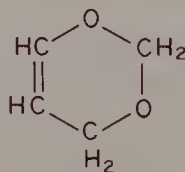
(1) Oxirane



(2) 1,3-Oxathiolane



(3) 2H,4H-1,3-Dioxine



(4) 1,2-Dihydroazete





# OFF THE PRESS

Recent IUPAC publications

## Chemistry for the Welfare of Mankind

Approaches that could provide chemical solutions for solving world problems were selected for this volume from the proceedings of the 26th International Congress of Pure & Applied Chemistry, held in Tokyo Japan on 4-10 September 1977. Symposia at that conference were organized with the recognition that the future of mankind, its prosperity and survival, is largely dependent on the progress of fundamental and applied chemistry and interdisciplinary cooperation among specialists in various fields.

This volume, the 1st of five based upon the Congress, contains two plenary lectures presented by chemists of world-wide recognition, and main lectures presented in five joint symposia.

### Contents:

Chemistry, macromolecules and the needs of man—by Dr. P. J. Flory

Pure and applied photochemistry—by Dr. G. Porter  
Selectivity and Specificity in Chemical Reactions (main lectures)

Phase Boundaries and multiphase Systems (main lectures)

Biologically active substances (main lectures)

Separation and Detection of Trace Substances (main lectures)

Modern Aspects of Industrial Materials and Resources (main lectures)

Editor-in-chief of the 476 page volume is Prof. T. Tsuruta. It costs US\$85, or can be purchased with the complete 5 volume set of lectures from the 26th International Congress, containing a total 842 pages, over 2000 references, available for US\$160.

Other lectures at the 26th Int'l. Congress of Pure & Applied Chemistry are collected into four volumes dealing with the subject areas of physical, analytical, organic and macromolecular chemistry.

## Physical Chemistry (Volume 2)

S. Nagakura—editor, six lectures, 100 pages, US\$24.

## Analytical Chemistry (Volume 3)

T. Takeuchi—editor, 76 pages, US\$24.

## Organic Chemistry (Volume 4)

T. Mukaiyama—editor, 76 pages, US\$24.

## Macromolecular Chemistry (Volume 5)

A. Nakajima—editor, 114 pages, US\$24.

*Lectures presented at IUPAC-sponsored conferences are initially published in the IUPAC journal, Pure & Applied Chemistry. Some, such as those described here, are selected for publication as individual bound volumes, which are supplied to subscribers of Pure & Applied Chemistry as part of their subscription. Delegates attending IUPAC-sponsored conferences can generally purchase the bound conference proceedings at a reduced rate.*

## Photochemistry

Twelve plenary lectures presented at the 7th IUPAC Symposium on Photochemistry (held in Leuven, Belgium on 24-28 July 1978) are contained in this volume. Topics covered by these lectures include: Chemistry of exciplexes; Photocycloaddition of anthracenes to conjugated polyenes; Photochemical synthesis of natural products; Photo-oxidation of polymers; Selected aspects of photochemistry in polymer media; and photochemistry of three-membered heterocycles. The 186 page volume was edited by Dr. A. Reiser, and published in July 1979. It is available in a hardcover edition, at a cost of US\$27.50.

## Organic Synthesis

Ten main lectures presented at the 2nd IUPAC Symposium on Organic Synthesis (Jerusalem and Haifa, Israel, 10-15 September 1978) are presented in this 138 page volume, edited by Prof. S. Sarel. The lectures deal with new methods in peptide synthesis, palladium catalysts in natural products synthesis, reactions forming asymmetric carbon-carbon bonds, an "absolute" asymmetric synthesis of chiral dimers and polymers, new alternatives to oxidative phenolic coupling in natural product synthesis, steric and electronic effects observed in propellane reactions, recent studies on synthesis of natural products, reactions based on onium salts of azaaromatics, and metalated isocyanates in organic synthesis. Due for publication in November 1979, the set of hardcover-bound volumes is available for US\$25.

## Ions and Ion Pairs

### & their role in chemical reactions

This hardcover volume contains invited lectures presented at the Int'l. Symposium on Ions and Ion Pairs (held in Syracuse, USA, 30 May - 2 June 1978). Topics covered by the lectures include: structure of solvated ion pairs, ion-solvent interactions, structure of alkali biphenyl ion pairs in solution and solid state, optical and NMR investigations of carbanions and nitranions, multinuclear NMR studies of alkali ions, and macrocyclic ligands on polymers. The 138 page book is edited by Prof. J. Smid, and will be available in September at a cost of US\$30.

## Chemistry of Natural Products

Dr. R. Vlahov edited this collection of eleven plenary lectures presented at the 11th International Symposium on Chemistry of Natural Products held 17-23 September at Golden Sands, Varna in Bulgaria. The lectures deal with the subjects of Unnatural alkaloids; Total synthesis of delphinine-type alkaloids; Biosynthesis of epidithiodioxopiperazines;



Palaeochemistry and biochemistry of the hopanoids; Studies on some biologically-active compounds; Total synthesis of natural products by thermolysis; Circular dichroism of natural products; Selectivity in total synthesis of natural products; Conformation interactions in biopolymers; Hormone receptor interactions; and biogenic concepts in terpene structure elucidation. The hardcover 182 page book was published in September 1979, and costs US\$30.

## Carotenoids

Nineteen papers presented at the 5th International Symposium on Carotenoids are collected in this publication, edited by Prof. T. W. Goodwin. The hardcover 278 page book was published in August 1979 at a cost of US\$36. Some of the subjects covered at that conference, held 23-28 July 1978 at Madison, Wisconsin USA, were: History and present

industrial application of carotenoids and vitamin A; Stereochemical, physico-chemical and synthetic studies on carotenoids; Synthesis of optically active carotenoids, carotenoid glycosylesters and related compounds; and Recent studies on biological functions of vitamin A.

IUPAC Publications are available from the publisher, Pergamon Press, to whom orders should be addressed. Pergamon Press has six distribution centres throughout the world.

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# THE LAST WORD

## The publishing game

Ever get the feeling that having your article published within a reasonable period of time is a scientific impossibility, or at least, hopelessly difficult? To help your publishing score, you might consider practicing "the publishing game". All that's required is a manuscript and a pair of dice. The rules of the game are described in detail in a commentary by Agnes M. Herzberg (of Imperial College, London) published in the April 1979 issue of *Physics Today*. Here, condensed from the original article, are the main rules and strategies.

The game is played with three teams, called "author", "referee" and "editor". The editor may take an independent stand, or side with either of the other two.

Play opens with submission of the paper by the author. At this point, the editor of the journal intervenes. He may decide at once, for any reason whatsoever, that the submitted papers is not suitable for publication in his journal. This is known as "instant rejection". In very rare cases, the editor may decide that

the paper is extremely suitable and accept the paper at once. This unusual event is known as "instant acceptance".

Instant acceptance is more likely to occur when the editor has not accepted enough papers for the next issue. It is, therefore, very helpful for the author to time the submission of his/her paper. An author wins the game when all his papers are instantly accepted; such an author is known as an *authority*.

More often, the editor will send the submitted paper to a referee. Since the editor is free to choose someone who will confirm his own opinion of the paper, this move is used in some situations to prolong the game.

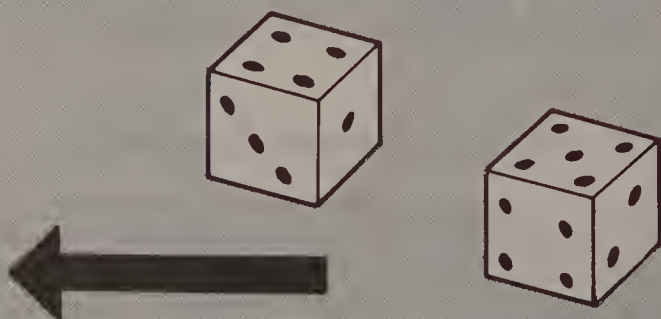
If the author feels that the referee and editor are taking too long with their moves, he can subtly remind them by sending trivial corrections to his paper.

The game does not have a time limit. Editors may remind referees that they are taking too long in contemplating their moves, but authors, because of a well-known unwritten rule, are never told to hurry.

The best tactic is to have arranged beforehand that an eminent person in the author's field (who is also on the editorial board of the journal) has suggested that the paper be submitted to the journal.

The game does not necessarily end in the way that the editor has intended. For example, the editor may be away at a pivotal move, and his assistant will change the course of the game. Such unexpected variations make the game more interesting for all players. The ultimate object of all players is, of course, to make your opponents forsake their serious work, and devote all their time to playing the game.

Go back 3 spaces





# Chemistry International

is the news magazine of the

# INTERNATIONAL UNION of PURE and APPLIED CHEMISTRY

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The International Union of Pure and Applied Chemistry (IUPAC), formed in 1919, is a voluntary, non-governmental, non-profit association of organizations, each of which represents the chemists of a member country.

Its objectives are:

to promote continuing co-operation among the chemists of the member countries;

to study topics of international importance to pure and applied chemistry which need regulation, standardization, or codification;

to co-operate with other international organizations which deal with topics of a chemical nature;

to contribute to the advancement of pure and applied chemistry in all its aspects.

The membership of IUPAC presently comprises 42 countries, each represented by a national organization, such as an academy of science or research council.

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Asociación Química Argentina (**Argentina**)

Australian Academy of Science (**Australia**)

Verein Österreichischer Chemiker (**Austria**)

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